IMPERIAL MYCOLOGICAL INSTITUTE
NOV 1947

PAPERS

OF THE

MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

XXXI (1945)

PART I: BOTANY AND FORESTRY

MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

VOLUME XXXI (1945)

PART I: BOTANY AND FORESTRY

VOLUME XXXI IS AVAILABLE IN THREE PARTS:

PART I: BOTANY AND FORESTRY

PART II: ZOOLOGY

PART III: GENERAL SECTION

ANTHROPOLOGY, GEOLOGY, HISTORY
LANGUAGE AND LITERATURE
PSYCHOLOGY, SOCIOLOGY

PAPERS OF THE MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

EDITORS
EUGENE S. McCARTNEY
HENRY VAN DER SCHALIE

VOLUME XXXI (1945)
PART I: BOTANY AND FORESTRY

"Pusilla res mundus est nisi in illo
quod quaerat omnis mundus habeat."
— SENECA, *Naturales Quaestiones*

ANN ARBOR: THE UNIVERSITY OF MICHIGAN PRESS
LONDON: GEOFFREY CUMBERLEGE, OXFORD UNIVERSITY PRESS
1947
All rights reserved

Copyright, 1947,
By The University of Michigan

Set up and printed,
August, 1947

PRINTED IN THE UNITED STATES OF AMERICA
BY THE PLIMPTON PRESS · NORWOOD · MASS.

CONTENTS

BOTANY

PAGE

Pacific Species of Galaxaura. II. Sexual Types. Ruth Chen-Ying Chou 3

Observations on the Habits of Some of the Native Plants of Kalamazoo County, Michigan. Clarence R. Hanes 25

The Bryophyte Flora of Michigan. William Campbell Steere .. 33

Algae Collected by the "Hassler," "Albatross," and Schmitt Expeditions. III. Marine Algae from Peru and Chile. Wm. Randolph Taylor 57

FORESTRY

Occurrence of Fungi in the Major Forest Types of Alaska. Dow V. Baxter 93

Some Resupinate Polypores from the Region of the Great Lakes. XVII. Dow V. Baxter 117

ILLUSTRATIONS

PLATES

BOTANY

FACING PAGE

CHOU: Pls. I–XIII. Sexual types of Pacific Ocean species of Galaxaura 24
TAYLOR: Pls. I–XIV. Marine Algae from Peru and Chili 90

FORESTRY

BAXTER: Pls. I–XVIII. Stages in the growth of forests in Alaska, zones of vegetation, types of fungi, and natural features 116
BAXTER: Pls. I–V. Resupinate polypores 130

FIGURES IN THE TEXT

BOTANY

PAGE

CHOU: Figs. 1–3. Sexual forms of Pacific Ocean species of Galaxaura .. 4

FORESTRY

BAXTER

Fig. 1. Bar formation at the mouth of the Koyukuk River, Alaska 95
Fig. 2. Profile of a transect in the Lower Yukon Valley, Alaska 96
Fig. 3. Outline of vegetative types encountered from pioneer stages to the climax after ice retreat 100
Fig. 4. Kenai Peninsula, Alaska 103
Fig. 5. Profile of a transect near the Russian River, Alaska 105
Fig. 6. Profile of a transect from the mountaintop back of Kodiak, Alaska 110
Fig. 7. Profile of a transect in the area of the Valdez Glacier, Alaska 114

BOTANY

PACIFIC SPECIES OF GALAXAURA
II. SEXUAL TYPES *

RUTH CHEN-YING CHOU

INTRODUCTION

BECAUSE of space limitation the first part of this paper, dealing with the asexual forms of Galaxaura in the Pacific, was separated from this second part, which covers the sexual forms. No real harm was done by the separation, because the sexual and the asexual forms of each species have not been associated with certainty as alternating phases in the life cycles of the actually existing natural species. The sexual and the asexual phases differ not only in the reproductive organs that they bear, but also in certain anatomical features that are restricted to one phase or the other. Consequently many more species are of necessity recognized than actually exist. When life-history studies shall have shown which sexual and asexual forms are to be associated, such an investigation as this will cease to be justifiable.

The goal of systematic studies of Galaxaura (and of other genera as well) is to unify and complete our knowledge of the natural species. Every proved association will eliminate a name from the literature, and eventually there will remain only a minimum number of species known only in one phase. In the meantime, however, primary division into sexual and asexual forms, with keys to each series, will prove the most practical and effective way of systematizing the types of the genus.

KEY TO THE SEXUAL FORMS OF GALAXAURA IN THE PACIFIC

SEXUAL TYPES

Plants sexual or cystocarpic; branches terete throughout or flattened above, villous or glabrous; cortical tissue parenchymatous, composed of a continuous

* Papers from the Department of Botany and the Botanical Garden of the University of Michigan, No. 749.

Part I of this article was published in *Pap. Mich. Acad. Sci., Arts, and Letters*, 30 (1944): 30–56.

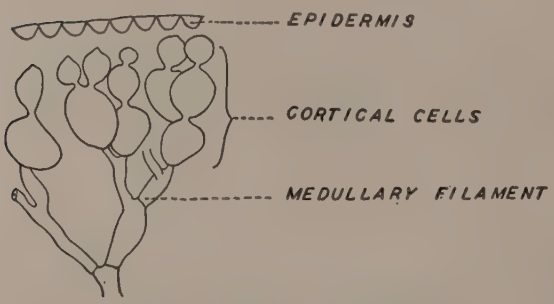


FIG. 1. Type of the Oblongatae

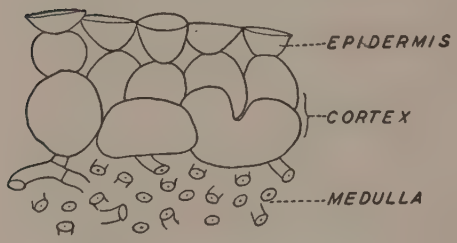


FIG. 2. Type of the Squalidae

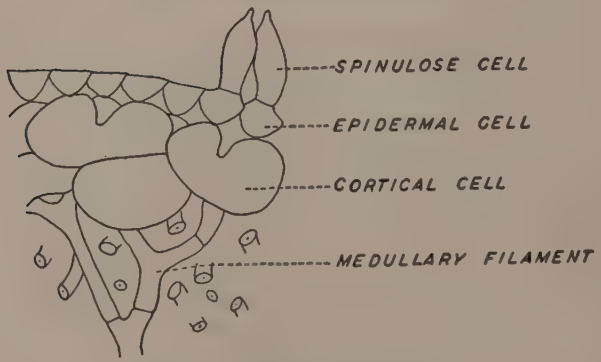


FIG. 3. Type of the Vepreculae

epidermis of chromatophore-bearing cells and a hypodermis of two or three layers of cortical cells which are either loosely arranged and subfilamentous as typified by the Oblongatae[1] (Fig. 1) or compactly and parenchymatously as ex-

[1] With regard to the innovations in sectional nomenclature, necessitated by the inconsistent and incorrectly formed names previously used, see Part I, p. 37.

emplified by the Squalidae (Fig. 2), the Vepreculae (Fig. 3), and the Angustifrondes.

1. Plants with branches terete throughout; cortical tissue with or without lobed cells, when present the latter innermost 2
1. Plants with branches flattened above, although terete below; lobed cells when present intermediate in position..... 7

2. Branches glabrous or subglabrous; cortical tissue parenchymatous or subfilamentous 3
2. Branches villous or hirsute; cortical tissue tristromatic; lobed cells present ..... (Section Squalidae) 6

3. Cortical tissue subfilamentous, remaining attached to medullary filaments after decalcification ..... (Section Oblongatae) 4
3. Cortical tissue parenchymatous ..... (Section Umbellatae) 5

4. Branches slender, commonly 0.5–1.0 mm., seldom exceeding 1 mm. in diameter ..... *G. cylindrica*
4. Branches coarse, 0.8–2.5 mm., commonly exceeding 1 mm. in diameter *G. oblongata*

5. Segments short, annulate-rugose, 1–2 mm. in diameter, seldom exceeding 5 mm. long, nodes constricted ..... *G. rugosa*
5. Segments long, smooth, 2–4 mm. in diameter, 0.5–2.5 cm. long, nodes articulate ..... *G. umbellata*

6. Branches hirsute; extended assimilatory filaments scattered singly, slightly stiff and brittle; epidermal cells 24–44 μ in diameter (surface view) ..... *G. glabriuscula*
6. Branches villous, at least below; extended assimilatory filaments often fasciculate; epidermal cells 12–24 μ in diameter (surface view) *G. squalida*

7. Epidermis bearing spinulose cells; cortical tissue with lobed cells present ..... (Section Vepreculae) 8
7. Epidermis smooth, without spinulose cells; cortical tissue with or without lobed cells ..... (Section Angustifrondes) 9

8. Thallus chalky, strongly spinulose, 1–2 mm. wide ..... *G. veprecula*
8. Thallus smooth, surface shiny, spinulose on the thickened margins only, 2–3 mm. wide ..... *G. ventricosa*

9. Cortical tissue tristromatic, lobed cells present; segments short, commonly not exceeding 1 cm. long ..... *G. angustifrons*
9. Cortical tissue 3- to 4-stromatic, without lobed cells; segments 1.0–2.5 cm. long ..... *G. intermedia*

Galaxaura cylindrica (Ell. & Sol.) Lamouroux. — Pl. I, Figs. 1–12; Pl. VIII, Fig. 1

Corallina cylindrica Ellis & Solander, 1786, p. 114, pl. 22, fig. 4; *Galaxaura cylindrica* Lamouroux, 1812, p. 22, pl. 22, fig. 4; Kjellman, 1900, p. 64, pl. 8, figs. 34–42, pl. 20, fig. 53; Børgesen, 1916, p. 106; 1927, pp. 77–78; Taylor, 1928, p. 138.

Plants densely bushy, up to 10 cm. or more high, attached to the substratum by a discoid holdfast; basal part short-caulescent, upper branches erect, angles narrow, more or less regularly dichotomous, sometimes subpinnate and subexcurrent, with main axes slightly coarser than the lateral ones; segments 5 to 10 mm. long, 0.5 to 1.0 mm. in diameter, terete, faintly rugose; proliferations single or stellate; medullary filaments 8 to 11 μ in diameter, toward the periphery closely and anticlinally branched with each ultimate branch terminated by two or three large subglobose or ellipsoidal closely arranged cells forming a pseudoparenchymatous cortical tissue; cells of pseudoparenchyma gradually diminishing in size outward; cells of the innermost layer subglobose or sometimes compressed and orbicular, 18 to 24 μ in diameter, each bearing one or two ellipsoidal or subglobose cells toward the outside, 5 to 25 μ high, 10 to 18 μ broad, often taller than wide, each in turn bearing one or two small subglobose cells 7 to 11 μ in diameter, forming a subepidermal layer; cells of the outermost layer (epidermis) strongly laterally coherent, parenchymatous, peeling off readily in sheets after decalcification, angular in surface view, semilunate in section, 8 μ high, 10 to 12 μ wide at the outer wall, chromatophore-bearing; conceptacles globose, embedded in the thallus, discharging by ostioles. (The specimens bear only immature reproductive bodies.)

The distinction between *G. cylindrica* and *G. oblongata* seems rather arbitrary, for the two plants are anatomically so similar that even experts fail to point out any noteworthy differentiating features that can be counted as valid specific characteristics. They are separated entirely on the basis of the diameter of the branches, that is, in *G. cylindrica* the branches are very slender, commonly not exceeding 1 mm. in diameter, whereas *G. oblongata* has branches from 1 mm. up in diameter. This characteristic alone naturally is hardly adequate for specific distinction; phycologists generally seem to agree, however, in accepting these two classical species, even when they do not agree upon accepting the numerous "Eugalaxaura" species proposed by Kjellman. Therefore the present identification of species from the Philippine Islands is likewise based solely on the relative diameter of the branches in material referred respectively to *G. cylindrica* and *G. oblongata*.

Kjellman, Børgesen, and others have all reported that the branches of *G. cylindrica* range from 0.5 to 0.75 mm. in diameter, a measure-

ment which is less than I have found in the Philippine plants, in which at least some of the branches reach 1 mm. However, when compared with other plants which I have called *G. oblongata*, the branches of these plants are definitely more slender; therefore I have decided to set the boundary between these two closely related species at 1 mm. If the slightly greater diameter of the Philippine plants holds good when more material comes to light, further studies may indicate that West Indian and Philippine plants are distinguishable.

Type locality. — West Indies.

Specimens studied. — PHILIPPINE ISLANDS: Dalupiri Island, Babuyan Group, *Bartlett 14981*, Oct. 31 — Nov. 5, 1935; Batan Island, Batanes Group, *Bartlett 15416*, July 20, 1935.

Further distribution. — Bermuda, West Indies, warmer Atlantic coast of America, Red Sea.

Galaxaura oblongata (Ell. & Sol.) Lamouroux. — Pl. II, Figs. 1–16; Pl. III, Figs. 1–14; Pl. IX, Figs. 1–2

Corallina oblongata Ellis & Solander, 1786, p. 114, pl. 22, fig. 1; *Galaxaura oblongata* Lamouroux, 1816, p. 262; Børgesen, 1927, pp. 71–77, figs. 39–41; Taylor, 1928, p. 139, pl. 21, fig. 5; 1941, p. 95; 1942, p. 84; 1945, pp. 142–143.

Plants forming dense round tufts 4 to 12 cm. or more high, attached by small discoid holdfasts; branching regularly dichotomous; branches fastigiate or spreading, glabrous, distinctly calcified, brittle and fragile when dried; segments cylindrical, 0.4 to 2.5 cm. long, 0.8 to 2.5 mm. in diameter, more or less annulately rugose, nodes fractured, constricted, or subarticulate, the diameter of the branches in a single plant uniform, but varying greatly between plants; proliferations common, single or stellate, present at nodes or internodes where the epidermis is ruptured; medullary filaments 4 to 12 μ in diameter, toward the periphery anticlinally and closely branched, each ultimate branchlet terminated by two to three subglobose cortical cells (excluding epidermal cells), connected successively by a narrow protoplasmic strand, thus cells of each branchlet remain attached after decalcification, the inner one or two cortical cells the largest, the basal cell subglobose or slightly compressed, wider than high, 20 to 40 μ in diameter, each bearing two cells, rarely a single oblong, obovate, or subglobose one, 16 to 36 μ tall, 12 to 32 μ wide, these in turn each bearing one, sometimes two small, subglobose cells, 8 to 18 μ in diameter, below the epidermis; epidermal cells closely arranged,

peeling off in sheets after decalcification, in surface view angular, 8 to 20 μ in diameter, in section semilunate; reproductive bodies common, male and female conceptacles globose, embedded in the cortical tissue, opening outwardly by an ostiole; spermatangia small, globose, about 4 μ in diameter, or elliptical, 20 μ long, 6 μ in diameter; female conceptacles large; production of first carposporangium sometimes followed by proliferation of a new carposporangium within the empty sporangial wall, and several sporangia may be successively proliferated as the growing season progresses; mature carposporangia large, oval or obpyriform, size variable, 16 by 20 μ to 50 by 70 μ in diameter.

From the numerous specimens examined I noted that some are so very fragile (*Bartlett 14248*) that they could easily be called *G. fragilis;* some have fastigiate branches which would go nicely with *G. fastigiata;* and some have very coarse branches which do not look the least like the others except for their anatomical structure. When I laid them all out, however, I found the variations overlapping. There are specimens of intermediate types to bridge over the extremes, so that it is impossible to draw any specific line that would include one and not exclude another.

If geographical distribution or range of these plants were to play a rôle in the determination of the species, then the plants from the Philippine Islands might be called *G. fastigiata*, since it is the type region for that species. However, my observations have led me to think that *G. fastigiata* is probably a physiological form, that is, the plant may have been grown under such favorable conditions that all the branches received equal chances for development, and therefore became equally tall, so that when pressed they appeared fastigiate. Under less favorable conditions, on the contrary, when normal growth is being constantly interrupted the branching becomes subpinnate, and the branches are unequal in length and in diameter. Both of these states have been observed among the Philippine plants at hand. Furthermore, under *Bartlett 14980* there are the robust, the fastigiate, and the subpinnate forms, all merging into one another along a gradient which would allow sufficient variation for different phases to be considered different species if one met them singly. Besides, there are two specimens, *Bartlett 16185* and *16200*, from Cebu Island, which externally do not look the least like any other *G. oblongata* from the vicinity. The plants are small, heavily calcified, with short poculiform or club-shaped internodes; so that at

first I was strongly inclined to treat them as new, but when carefully examined they were found to be only young plants structurally identical with those of *Bartlett 14980*, which I have called *G. oblongata*.

Because of the structural similarity I regarded the Oblongatae at hand whose branches exceed one millimeter in diameter as *G. oblongata*, and those below one millimeter as *G. cylindrica*. *G. oblongata*, as I have interpreted it, may in the future turn out to be species complex, embracing the sexual phases of more than one species, or perhaps even the species of a distinct genus or subgenus with several haplobiontic species. However, it must be admitted that at present it is not possible to segregate them.

Type locality. — "West Indies."

Type specimen. — "Ellis and Solander's specimen no longer exists."

Specimens studied. — MEXICO: Near Isla María Magdalena, dredged at depths of 5.5 and 21.5 meters, *Taylor 39–667A* and *39–653*, May 9, 1939; ECUADOR: Bahía San Francisco, Esmeraldas, *Taylor 34–485*, Feb. 11, 1934; PHILIPPINE ISLANDS: Dalupiri Island, Babuyan Group, *Bartlett 14607*, July 17; and *14980*, Oct. 31—Nov. 5, 1935; Luzon, Subic Bay, Subic, Zambales Province, *Bartlett 14140*, May 31, 1935; Sinait, Ilocos Sur Province, *Bartlett 14237*, *14248*, June 2, 1935; *Moises Kalaw 6*, June 12, 1935; Cavite Province, *Bartlett 14585*, July 7, 1935; Wawa, Nasugbu, Batangas Province, *J. V. Santos 120*, July 14, 1935; Mindoro, Puerto Galera, *Bartlett 13778*, *13785*, May 12–17, 1935; Cebu Island, Liloan Beach, *Bartlett 16185* and *16200*, Sept. 20, 1935; JAVA: Eiland Kerkhof, Baai van Batavia, *Kostermans 32*, Sept. 26, 1938; SUMATRA: Belimbing (south coast of Sumatra), *Kostermans 773*, Oct. 20, 1938.

Further distribution. — Florida, Dry Tortugas, West Indies, Brazil, Adriatic Sea, Red Sea, Australia, Timor, Hainan Island, Hong Kong, Japan.

Galaxaura squalida Kjellman. — Pl. IV, Figs. 1–11; Pl. VIII, Fig. 2

Kjellman, 1900, pp. 55–56, pl. 6, figs. 1–12, pl. 20, fig. 9; Børgesen, 1916, pp. 102–105, figs. 108–111; Taylor, 1928, p. 140, pl. 21, fig. 18, pl. 31, fig. 4; 1942, p. 84; 1945, p. 142.

Plants bushy, up to 10 cm. or more high, attached by a broad discoid holdfast; branching dichotomous, angles narrow or acute;

branches terete, villous, the upper more or less glabrous; segments 0.5 to 2.0 cm. long, 1 to 2 mm. in diameter, annulate-rugose, basal ones often short, closely forking (the branches thus appearing quasi-umbellate); proliferations solitary or geminate, base cupuliform; extended assimilatory filaments fasciculate, fascicles evenly distributed or subverticillate toward the apex of the branches, seldom exceeding 1 mm. long, diameter 15 to 18 μ, composed of short cylindrical cells 1.5 to 2.0 times as long as broad; medullary filaments 7 to 18 μ in diameter, cortical tissue parenchymatous, tristromatic; cells of the innermost layer the largest, more or less globose, 22 to 40 μ in diameter, some 2- or 3-lobed, and their diameter one to two times wider than high; cells of the intermediate layer smaller, globose or ovate, 18 to 25 μ in diameter; cells of the outermost layer (epidermis) closely arranged, of two kinds: either (*a*) angular in surface view, 14 to 22 μ in diameter, in section semilunate, 10 to 15 μ tall by 18 to 25 μ broad at the outer wall; or (*b*) circular and slightly elevated above the general level of the surface (these may be the basal cells of extended assimilators identical with what others call "abortive cells"); conceptacles spherical, embedded in the medullary layer, with ostioles opening through the cortical tissue; carposporangia ovate or elliptical, about 50 μ long by 30 μ in diameter.

In the section Squalidae (Microthoë) Kjellman distinguished a West Indian plant as *G. squalida* and a Japanese plant as *G. cuculligera;* the latter is characterized by having cucullate proliferations. This segregation has been adopted by most modern workers, and the plants from Pacific waters recorded under the name *G. cuculligera* (as, for example, by Weber–van Bosse, Butters, Tanaka), and those from the Atlantic as *G. squalida* (by Collins and Hervey, Howe, Børgesen, Taylor).

The presence of *G. cuculligera* has been recorded by Japanese workers, but the occurrence of *G. squalida* in the Pacific Ocean, so far as I can trace it, has not hitherto been noted. Nevertheless, in the Philippine materials that I have examined there are some plants which bear cucullate branches and others which do not. Structurally, however, I have not been able to detect any noteworthy differences between the two, so that, presumably, the cucullate condition may have been brought about by a sudden interruption of the normal rate of growth. This condition is evident in *Bartlett 14982*, for here one can readily see that the older part of the plant is very muddy. It

seems that the plant was for a time buried in mud or covered by it and that the new growth regenerated from the center of the axis, so that the basal part was surrounded by the peripheral tissue of the older branch — a state which is similar to regeneration of the lost parts. Furthermore, since the cucullate state also appears on the West Indian plants, as well as being common to other species of Squalidae, since it is absent in some of the Philippine plants, and since microscopical examination yields no evidence for the separation of the two forms, I am in this case adopting a broader view of the species and refer these Philippine plants to *G. squalida*, viewing the cucullate condition in some specimens as ecological or physiological and regarding it as having been brought about by external factors.

Type locality. — St. Croix, Virgin Islands.

Type specimen. — In Areschoug's herbarium, under the name *G. rugosa.*

Specimens studied. — PHILIPPINE ISLANDS: Dalupiri Island, Babuyan Group, *Bartlett 14982*, Oct. 31—Nov. 5, 1935; Lubang Island, Mindoro, *Villaflores 6*, *7*, *8*, Aug. 24, 1935; SOCIETY ISLANDS: Tahiti, *Brooks* in Taylor herbarium *20495*, Dec., 1932; PANAMA: Bahía Honda, *Taylor 39–130*, March 26, 1939.

Further distribution. — Bermuda, Florida, Bahamas through the West Indies to the Virgin Islands.

Galaxaura glabriuscula Kjellman. — Pl. IV, Figs. 14–20; Pl. X, Fig. 1

Kjellman, 1900, p. 56–77, pl. 7, figs. 1–2, pl. 20, fig. 26; Butters, 1911, pp. 175–176; Tanaka, 1936, pp. 151–152, figs. 12–13, pl. 37, fig. 1.

Plants with branches up to 9 cm. or more high, the basal attachment not seen; branches often much crowded above, forming corymbose or flabelliform tufts; the lower part hirsute, the upper sparingly hairy or often subglabrous, apex smooth and glabrous; segments ranging from 2 or 3 mm. to 15 (or more) mm. long, 0.8 to 2.0 mm. in diameter; proliferations solitary, base cucullate, inconspicuously encircled by a tuft of extended assimilatory filaments; the central axis traversed by few loosely entangled filaments 7 to 16 μ in diameter; cortical tissue parenchymatous, tristromatic, about 80 μ thick; cells of the innermost layer the largest, subglobose, often slightly wider than high, diameter 30 to 48 μ, some 2- or 3-lobed, one or two times

wider than high; cells of the intermediate layer smaller, subglobose, loosely arranged with intercellular spaces filled with lime, diameter 28 to 44 μ, containing stellate chromatophores each with a pyrenoid at the center; cells of the outermost layer forming the epidermis, closely arranged, parenchymatous, angular in surface view, 28 to 36 μ in diameter, in section semilunate, 12 to 16 μ tall, 28 to 40 μ wide, including the outer wall; extended assimilatory filaments evenly distributed, slightly stiff and thus easily fractured, shaft simple or branched, basal part 15 μ, apical part 18 μ in diameter, cells one and one half to two times as long as the diameter; hair-bearing epidermal cells slightly raised above the level of the surrounding epidermal cells, circular in surface view, with a circular perforation when the hair becomes detached; conceptacles spherical, embedded in the thallus, discharging through small ostioles; carpospores clavate or pyriform.

The Javanese plants which I assign to *G. glabriuscula* are very much like *G. squalida* in habit, but differ anatomically in the following respects:

The epidermal cells of *G. glabriuscula*, in general, are larger than those of *G. squalida*, that is, those of the former commonly range from 28 to 44 μ in diameter, whereas those of the latter rarely exceed 20 μ in diameter. The lobed cortical cells in *G. glabriuscula* are more common and larger than those of *G. squalida*. The extended assimilatory filaments of *G. glabriuscula* are few, thinly scattered, relatively stiff and brittle in texture when compared with those of the closely related species. Lastly, the presence of yellow pigment in the chromatophores has been regarded by several writers as unique in this species.[2]

The yellow color, however, is not particularly noticeable in the present Javanese plants, but microscopical examination does show the presence of a yellowish tinge in the chromatophores. If it should prove that the species is characteristically yellow, then the yellow-tinted chromatophore in these plants indicates that they did contain

[2] Ordinarily I am not much in favor of using color as a criterion for specific determination in Galaxaura, but since the presence of a yellow pigment has been mentioned by every author who describes *G. glabriuscula* and since this yellow color is different from other pigments which one finds in the red algae, I have tentatively decided to accept a color character in this case and have assigned these plants from Java to *G. glabriuscula*. It is possible, if the presence of yellow pigment is alternative to the presence of red in the red algae, that there may be other yellow types, perhaps yellow varieties or ecological variants of red species.

yellow pigment, but failed to retain more than a trace of it because they were preserved in formaldehyde before mounting.

Type locality. — Tahiti.

Type specimen. — In Areschoug's herbarium under the name *Galaxaura rugosa.*

Specimens studied. — Java: Eiland Kělapa, Duizend-eilanden, *Kostermans 254*, Oct. 5, 1938.

Further distribution. — Bonin Islands, Tahiti, Hawaiian Islands.

Galaxaura rugosa (Ell. & Sol.) Lamouroux. — Pl. IV, Figs. 12–13; Pl. X, Fig. 2

Kjellman, 1900, p. 55; Børgesen, 1915–20, p. 100, figs. 105–106; Howe, 1920, p. 558; Taylor, 1928, p. 140, pl. 21, fig. 16, pl. 30, figs. 2, 10; 1941, p. 95; 1942, p. 84.

Plants up to 4 cm. high; branching regularly dichotomous; segments short, 2 to 5 mm. long, 1 to 1.5 mm. in diameter, terete, glabrous, distinctly annulate–rugose, continuous or constricted at the nodes; medulla composed of loosely entangled filaments 7 to 15 μ in diameter; the cortical tissue tristromatic, cells of the innermost layer largest, some 2- or 3-lobed, others globose or subglobose, often slightly wider than tall, 20 to 40 μ high, 30 to 40 μ in diameter; cells of the intermediate layer smaller than the inner ones, subglobose or obovate, 25 to 30 μ tall, 15 to 22 μ in diameter, containing stellate chromatophores with a pyrenoid at the center; cells of the outermost layer (epidermis) angular in surface view, 18 to 26 μ in diameter, in section semilunate, 8 to 15 μ tall, 18 to 22 μ in diameter, containing well-developed chromatophores; conceptacles spherical, embedded in the thallus, with ostioles opening through the thin cortical parenchymatous tissue; reproductive bodies immature.

The determination of this single specimen from Batan Island, Philippines, may seem unnatural, for it is commonly accepted that *G. rugosa*, based on a plant from Jamaica, is limited to the Atlantic waters, and similar Pacific plants have been given the name *G. elongata.* According to the type description, however, Agardh's *G. elongata*, based on plants from Tonga and Australia, was much taller and larger than *G. rugosa.* It was described as 3 to 6 inches tall, with branches as thick as a "crow's quill," whereas the present Philippine plant is only 3 to 4 cm. high, with branches commonly 1.0 to 1.5 mm in diameter.

As for Lamouroux's *G. rugosa*, it was based on Ellis and Solander's plant from the Jamaican coast, which was well illustrated by Plukenet (1691, pl. 168, fig. 4). Having compared the Batan Island plant with Plukenet's illustration of the Jamaican plant, without the least doubt I consider this Philippine plant to be identical with the West Indian one and therefore it is referred to *G. rugosa* (Ell. & Sol.) Lamouroux.

Opinion of taxonomists in the field seems to agree that *G. rugosa* is distinguished from other closely related species of the Rugosae in having branches distinctly annulate–rugose and more or less glabrous, with little or no development of extended assimilatory filaments. The present determination of a single specimen from Batan Island is based upon these two characteristics.

This Philippine plant (*Bartlett 15410*) agrees closely with Børgesen's description of the West Indian plant, except that it is very smooth, without any visible extended assimilatory filaments. Microscopical examination of the epidermal cells shows, however, the presence of circular cells which are slightly raised above the level of the angular epidermal cells and suggests potential or abortive basal cells corresponding to extended assimilatory filaments.

The branching of *G. rugosa* is very regularly dichotomous, being much more regular than that of the closely related species *G. glabriuscula* and *G. squalida*. In texture the plant is rather delicate, with wall of the thallus thinly membranous, and therefore rather fragile after decalcification.

Type locality. — Jamaica, British West Indies.

Specimens studied. — Philippine Islands: Beach at Basco, Batan Island, *Bartlett 15410*, July 20, 1935.

Further distribution. — Florida, Bahamas through the West Indies to the Virgin Islands.

Galaxaura umbellata (Esp.) Lamouroux. — Pl. V, Figs. 1–6; Pl. XI, Fig. 1

Tubularia umbellata Esper, 1830,[3] p. 125, Tubularia, pl. 17, figs. 1–2; *Galaxaura umbellata* Lamouroux, 1812, p. 185; Lamouroux, 1816, p. 262; J. G. Agardh, 1876, p. 526; Kjellman, 1900, p. 88 (only the name mentioned).

---

[3] *Tubularia umbellata* was cited by Lamouroux (1812) as having been published in "Esper Zooph., tab. 17, fig. 1–2." I have not been able to obtain this work, and so cannot give the exact title and date. However, both the descrip-

Plants forming tufts 5 to 6 cm. high; branches terete, glabrous, fastigiate, one to three or more times dichotomous, angles narrow and branches erect; thallus thin-walled, membranous, slightly nitent, segments 0.5 to 3.0 cm. long, 2 to 4 mm. in diameter, subarticulate or strongly constricted at the nodes; apex round with the growing point restricted to a tiny perforation in the center; medulla traversed by few loosely interwoven filaments 7 to 16 μ in diameter, cortical tissue tristromatic, cells of the innermost layer the largest, often compressed, more or less rectangular in section, commonly wider than high, 40 to 90 μ in diameter, 30 to 36 μ tall; cells of the intermediate layer variable, some subrectangular, like those of the innermost layer, some subglobose, 18 to 22 μ high, 20 to 40 μ wide; cells of the outermost layer closely arranged, forming an epidermis, in surface view angular, 20 to 30 μ in diameter, in section semilunate, 8 to 15 μ high, 20 to 30 μ wide, containing well-developed stellate chromatophores with a large pyrenoid in the center; conceptacles very young, reproductive bodies immature.

Practically no difficulty has been encountered in referring this plant to its proper section, because both the anatomical structure of the thallus and the presence of the sexual reproductive bodies place it clearly in the Umbellatae (= Kjellman's Dichotomaria, Spissae). There is a problem, however, in assigning the plant to the proper species, for in his monograph Kjellman recognizes a total of six undistinguished species under "Spissae," namely, *G. obtusata* Lamouroux (*Corallina obtusata* Ell. & Sol.), *G. umbellata* Lamouroux (*Tubularia umbellata* Esper), *G. Decaisnei* Agardh, and his three newly established species, *G. tumida*, *G. insignis*, and *G. corymbifera*. In maintaining the older and proposing the new species he did not present any clear-cut specific characters and, in fact, for the old species did nothing more than merely mention the names, without giving diagnostic characteristics.

Because of their great structural similarity the Umbellatae are separated almost entirely by external differences, such as the general habit of the plants and the length and diameter of the internodes. All these external characteristics are highly subject to environmental,

---

tion of *Tubularia umbellata* and the plate of figures were republished in Esper's *Die Pflanzenthiere* in 1830, eighteen years after the appearance of Lamouroux's *Histoire des polypiers coralligènes flexibles vulgairement nommés zoophytes*, to which the present reference is made.

physiological, or developmental modification and, therefore, taxonomists have different opinions about the validity of the species which have been proposed. The two classical species, *G. umbellata* and *G. obtusata*, were recognized by early workers, whereas in modern publications only *G. obtusata* has been recorded.

These plants from Dalupiri, Philippine Islands (*Bartlett 15022*), agree very closely in height and in length and diameter of the internodes with Esper's illustration of *G. umbellata* from the East Indies; therefore I do not hesitate to place them with *G. umbellata*. This decision cannot be called arbitrary, for the Philippine Islands and the East Indies are within the geographical range of many species. Also, since *G. umbellata* took the lead in the first list of the Galaxaura species, in 1812, it might be considered the generic type ("standard species"), and therefore not to be thrown into synonymy, as was done by Børgesen.

Type locality. — East Indies, according to Kjellman.

Specimens studied. — Philippine Islands: Dalupiri Island, Babuyan Group, *Bartlett 15022*, Oct. 31–Nov. 5, 1935.

Further distribution. — Africa (Port Natal), Australia, West Indies, tropical Atlantic Ocean.

Galaxaura veprecula Kjellman. — Pl. VI, Figs. 1–8; Pl. XII, Fig. 1

Kjellman, 1900, pp. 80–81, pl. 16, figs. 17–33, pl. 20, fig. 20; Yendo, 1918, p. 66; De Toni, 1924, p. 137; Tanaka, 1936, pp. 169–170, figs. 36–37, pl. 43, fig. 1; Taylor, 1945, p. 143.

Plants briefly caulescent, up to 8 cm. or more high, attached to the substratum by a broad discoid holdfast; caudex villous, upper branches widely effuse or flabelliform, distinctly flattened, branching regularly or subregularly dichotomous, sometimes subpinnate with branches unilaterally developed, thus causing the main axes to arch; internodes continuous, sometimes subarticulate and proliferous, 0.5 to 1.2 cm. long, 1 to 2 mm. in diameter, cuneate or subcuneate; thallus smooth and slightly shiny where there are no spinulose cells, but dirty-chalky and farinaceous where covered by spinulose cells; proliferations common, each encircled at the base by a tuft of extended assimilatory filaments 1.0 to 1.5 mm. long; medullary filaments 7 to 12 μ in diameter, cortical tissue tristromatic, 48 to 80 μ thick; cells of the innermost layer subglobose or compressed, often

wider than high, 20 to 30 μ tall, 35 to 45 μ broad, cells of the intermediate layer very large, subglobose, 22 to 30 μ tall, 25 to 40 μ broad, some 2- to 3-lobed, in diameter two or three times broader than tall, cells of the outermost layer (epidermis) chromatophore-bearing, in surface view angular, 16 to 28 μ in diameter, in section semilunate, 10 to 15 μ tall, 8 to 20 μ broad at the outer edge; spinulose cells occurring in patches, irregularly scattered over the surface of the thallus, commonly appearing on the thickened margins first, easily rubbed off or deciduous, clavate or elongate–spatulate, 25 to 35 μ tall, 12 to 15 μ in diameter, apex pointed or mucronate; conceptacles spherical, embedded in the thallus, each opening outward by an ostiole; female plants often with cystocarpic ostioles opening on or near the thickened margins of the thallus; carpospores ovoid or pyriform, 20 to 25 μ by 35 μ in diameter; male conceptacles more numerous, ostioles evenly scattered all over the surface of the thallus; spermatia very small, about 4 μ in diameter.

Superficially this species is almost inseparable from the nonsexual plants of section Arboreae, and likewise from smooth sexual Angustifrondes, and they are often found in the same collection in herbaria, or in nature growing with the tetrasporic plants of Arboreae, thus indicating intimate association of the two forms, which has led to Howe's hypothesis of sexual dimorphism of these algae. However, the development of the spinulose cells on the epidermis makes the plants anatomically unique and distinguishable from the smooth species of Angustifrondes.

In the single collection (*Bartlett 15009*) of Philippine plants thirteen of twenty-five specimens are sexual forms, with seven bearing cystocarps, two with spermatangia and four which are anatomically sexual, although no reproductive organs have been observed. The remaining twelve (*Bartlett 15009a*) are anatomically tetrasporic plants belonging to the Arboreae, even though tetraspores have not been found.

Although the nonsexual and the sexual plants do appear superficially identical, nevertheless, when one is familiar with these it is not difficult to distinguish them even without the aid of a low magnifier, for the thallus of the tetrasporic plant is slightly shiny, sometimes even iridescent to a slight extent, so that Børgesen described it as "often smooth and glossy, sometimes shining like mother of pearl."

Type locality. — Indian Ocean, near Madagascar Island.

Type specimen. — In Upsala herbarium under the name *G. marginata.*

Specimens studied. — PHILIPPINE ISLANDS: Dalupiri Island, Babuyan Group, *Bartlett 15009*, Oct. 31–Nov. 5, 1935; Batan Island, *Bartlett 15411*, July 20, 1935; COSTA RICA: Golfo Dulce, *Taylor 39–90b*, *39–91b*, *39–92b*, March 26, 1939; ECUADOR: Isla San Cristóbal, dredged from two to three fathoms, *Schmitt 41C–33*, Jan. 30, 1933.

Further distribution. — Madagascar, Formosa.

Galaxaura ventricosa Kjellman. — Pl. VI, Figs. 9–12; Pl. XII, Fig. 2

Kjellman, 1900, p. 81, pl. 16, figs. 11–16, pl. 20, fig. 24; Taylor, 1945, pp. 143–144.

Plants closely resembling *G. veprecula;* basal attachment not seen; the upper part of the branches strongly flattened, as much as 7.0 to 8.5 cm. high; texture carnose or subcoriaceous–membranous, flattened surface smooth, glabrous, even nitent, ultimate part of branches thin, membranous, or translucent; internodes continuous, rarely constricted or fractured at the base of the forkings, margin thickened, 0.5 to 1.2 cm. long, 2 to 3 mm. wide; proliferations few, when present each encircled at the base by a tuft of extended assimilatory filaments about 1 mm. long; spinulose cells of the epidermis found only on the thickened margins of the thallus; medullary filaments 8 to 15 μ in diameter; cortical tissue parenchymatous, tristromatic, 60 to 75 μ thick (excluding the spinulose cells); cells of the innermost layer strongly compressed, 20 to 36 μ high, 56 to 80 μ broad; cells of the intermediate layer variable in size and in shape, commonly 30 to 36 μ high by 35 to 44 μ broad, subglobose or some 2- or 3-lobed, with the diameter two to three times greater than the height, those below the thickened margins often subcylindrical, twice as tall as broad radially; cells of the outermost layer chromatophore-bearing, forming an epidermis, in surface view angular, 20 to 36 μ in diameter, in section semilunate, 12 to 24 μ high, 24 to 35 μ broad at the outer wall; spinulose cells columnar, fusiform, or elongate–spatulate, 32 to 40 μ high, 12 to 20 μ in diameter (commonly 16 to 18 μ), with the apex rounded or acute, sometimes short-acuminate or slightly mucronate; extended assimilatory filaments at the base of the proliferations 12 to 16 μ in diameter, their tumid basal cells obovoid, elliptical or obpyriform,

48 to 68 μ long, 24 to 32 μ in diameter at the broadest part; shaft cells cylindrical, two to four times as long as broad, containing well-developed chromatophores; conceptacles embedded in the thallus. Plant bearing immature reproductive bodies.

Anatomically *G. ventricosa* is inseparable from *G. veprecula*, but morphologically is distinguished by its broader thallus, with a lesser development of the spinulose cells, which are limited to the margins of the thallus, and the more or less continuous branches with fewer proliferations. The thallus of *G. ventricosa* has a diameter of about three millimeters. Its internodes are nearly equal in diameter throughout, or with the upper end only slightly wider than the lower, whereas those of *G. veprecula* seldom exceed two millimeters in width and the internodes are often cuneate, with the upper end distinctly wider than the lower.

The spinulose cells of *G. veprecula* are irregularly scattered all over the surface of the thallus, but in *G. ventricosa* they are more or less localized on the thickened margins of the thallus. These spinulose cells vary somewhat in size and shape even in the same thallus, and therefore may not have any taxonomic significance at all. Nevertheless, it might be worth while to mention in this connection that in *G. ventricosa* they are generally of slightly larger diameter than in *G. veprecula.*

Type locality. — Near the mouth of Gabon River, Africa.

Specimens studied. — Mexico: Dredged at 21.5 m. depth, near María Magdalena Island, *Taylor 39–652*, May 9, 1939.

Further distribution. — Near Gabon River, Africa.

Galaxaura angustifrons Kjellman. — Pl. VII, Figs. 1–5; Pl. XI, Fig. 2

Kjellman, 1900, p. 82, pl. 15, figs. 11–25, pl. 20, fig. 27; Weber-van Bosse, 1921, p. 219; Taylor, 1945, p. 144.

Plants bushy, up to 9 to 10 cm. high, basal parts of the branches subterete, more or less villous, the upper ones distinctly flattened; branching regularly dichotomous, angles open, rounded or acute; segments short, commonly 5 to 7 mm. long, 1.5 to 2.0 mm. wide, continuous, margins slightly thickened; proliferations few, each encircled at the base by a tuft of extended assimilatory filaments 0.5 to 1.0 mm. long; medullary filaments 8 to 16 μ in diameter; peripheral parenchyma tristromatic, 80 to 100 μ thick; cells of the innermost layer the

largest, subglobose or angular, compressed, 30 to 50 μ high, 40 to 100 μ broad; the intermediate layer composed of subglobose or ovate cells 24 to 38 μ in diameter, and among these are lobed cells two or three times as broad as high; cells of the outermost layer constituting the epidermis, angular in surface view, 20 to 30 μ in diameter, and in section semilunate or hemispherical, 16 to 24 μ tall by 20 to 28 μ wide, containing well-developed chromatophores; extended assimilatory filaments 15 μ in diameter, slightly attenuated toward the apex; tumid basal cell obpyriform or elongate–elliptical, 48 μ long, 28 to 30 μ in diameter; shaft cells 2 or 3 times as long as thick; young filaments few-celled, composed of shorter cells whose apical cells are ovate or round; conceptacles embedded in the thallus, with ostioles opening near the thickened margins of the thallus; reproductive bodies immature.

Superficially *G. angustifrons* is practically inseparable from *G. veprecula;* in structure also the two species show close correspondence in the width and length of the internodes, the presence of the lobed cells in the intermediate layer of the cortical tissue, and in the size of the epidermal cells. However, the presence or the absence of the spinulose cells on the epidermis supplies the specific distinction, that is, *G. angustifrons* is characterized by having a glabrous thallus, whereas *G. veprecula* has a chalky or "dusty" thallus because of the development of the spinulose cells over all the surface or at least on the thickened margins. The cortical tissue of *G. angustifrons* commonly exceeds 80 μ in thickness; that of *G. veprecula* is generally less than 80 μ. In surface view the epidermal cells vary greatly in size and thus afford no distinguishing features.

Type locality. — Bahía, Brazil.

Type specimen. — In Areschoug's herbarium.

Specimens studied. — Ecuador: Isla Santa Cruz, *Schmitt 81B–33,* Feb. 16, 1935.

Further distribution. — Brazil, Java.

Galaxaura intermedia, sp. nov. — Pl. VII, Figs. 6–10; Pl. XIII

Taylor, 1945, pp. 144–145.

Plantae deliquescentes, arborescentes, minus quam 23 cm. altae, disco ad substratum adfixae; caudice partibusque ramorum basalibus

subteretibus, villosis; ramis sursum compressis, glabris; segmentis linearibus, continuis, 1.0–2.5 cm. longis, 1–2 mm. latis, gelatinosis, coriaceis, vix calce incrustatis, siccitate fragilibus, inconspicue transverse striatis, marginibus neve incrassatis neve involutis; filamentis medullariis 10–12 μ diametientibus, cortice parenchymatoso, 3- vel 4-stromatico, minus quam 100 μ crasso, cellulis intimis quam aliis grandioribus, ovoideis vel subrectangularibus, 28–40 μ altitudine, 50–70 μ diametro; cellulis intermediis hypodermaticisque minoribus quam intimis, subglobosis, cellulis epidermatis crasse circumvallatis, angularibus, 12–20 μ diam., in sectione transversali frondis lunatis, 10–18 μ altis, 16–24 μ diam.; liberis filamentis assimilatoriis basi 16 μ, diam., ad apicem versus 18–20 μ, cellulis isodiametricis vel interdum duplo longioribus quam latioribus, absque vel cum cellulis tumidis basalibus; conceptaculis globosis, in thallo immersis, ostiolis ad superficiem aperientibus. Rami carpogoniales desunt.

Specimen typicum. — In loco dicto "Black Beach Anchorage," Insula Santae Mariae, in Insulis Galapagorum, legit W. R. Taylor n. 34–213, Jan. 17–18, 1934; in herb. "Hancock Foundation," Universitatis Californiae Australis; duplum in herbario Universitatis Michiganensis.

Plant tall, as much as 23 cm. or more high, attached by a discoid holdfast, the basal part strongly caulescent, caudex villous, about 2 cm. long, 3 to 5 mm. thick at base; branches dichotomous, angles narrow, acute, slightly villous and subterete toward the base, flattened above, glabrous; segments linear or linear–cuneate, continuous, 1.0 to 2.5 cm. long, 1 to 2 mm. wide, subcoriaceous or carnose–membranous, more gelatinous and less calcified than other known species, brittle when dried; inconspicuously striated, margin neither thickened nor involute; thallus attenuate toward the apex, less than about 1 mm. wide; medullary filaments subequal, 10 to 12 μ in diameter; cortical tissue strongly parenchymatous, 3- to 4-stromatic, about 100 μ thick; cells of the innermost layer the largest, subglobose, rectangular, 28 to 40 μ tall, 50 to 70 μ in diameter, generally wider than tall, cells of the intermediate layers more or less globose, ovate, larger in 1-layered parts than in 2-layered; lobed cells not seen; the outermost layer or epidermis composed of thick-walled cells, angular in surface view, 12 to 20 μ in diameter, in sectional view semilunate, 10 to 18 μ tall, 16 to 24 μ wide; extended assimilatory filaments cylindrical, slightly contracted toward the base, with or without tumid

basal cells; shaft cells 16 to 20 μ in diameter, one to two times as long as wide; conceptacles embedded in the thallus, with ostioles opening on the surface; reproductive bodies immature.

The species is characterized by having a smooth, glabrous thallus whose epidermal cells are free from the development of spinulose cells — a characteristic that is considered by Kjellman a sufficient basis for the separation of sections Angustifrondes (his Laevifrons) and Vepreculae. It may further be distinguished by the very thick outer wall of the epidermal cells, containing a high percentage of gelatinous substance which absorbs moisture readily in damp weather.

The section Angustifrondes has hitherto been composed of only two species, as first proposed by Kjellman. The first species, *G. magna*, is based on plants from Cape Agulhas, Africa, and the other, *G. angustifrons*, on plants from Bahía, Brazil. In the section the Ecuadorian plant seems to have a position intermediate between its two predecessors, for it possesses some characteristics in common with *G. magna* (a species that has been omitted from the present treatment because of lack of material), and some with *G. angustifrons*.

The new species agrees with the description of *G. magna* in almost every respect except for its much narrower branches, which, in fact, are the narrowest in all the three species of the Angustifrondes so far proposed. The thick gelatinous cell wall of *G. intermedia* expands considerably when it comes in contact with moisture. Thus in damp weather, when the humidity of the air is high, the specimen can absorb enough moisture to loosen itself from the herbarium sheet. On the contrary, under dry conditions the thallus becomes rather brittle, like that of Chondrus or Laminaria. Its low content of lime is shown by the release of few bubbles in decalcification.

Among the duplicates under this number (*Taylor 34–213*) I have recently detected one tetrasporic specimen which is identical in structure with the tetrasporic plants (*Taylor 34–164*) of Santa Maria Island, Galápagos, that I have assigned to *G. spathulata* Kjellm. (Chou 1945, p. 53). Because of the similarity in size of these two forms a suggestion was made in connection with the discussion of *G. spathulata* that a sexual plant which is likewise tall and arborescent might represent the sexual phase of *G. spathulata*. The finding of this tetrasporic plant among the sexual forms further strengthens my presumption that those nonsexual plants treated under the name *G. spathulata* and the sexual plants described under the present new name *G. intermedia*

are representatives of the two phases of one life history. More collecting and study will be necessary to validate this hypothesis.

Specimens studied. — Ecuador: Black Beach Anchorage, Isla Santa Maria, Galápagos Islands, *Taylor 34–213* (type), Jan. 17–18, 1934.

Further distribution. — So far as known, endemic to the Galápagos Islands in the eastern Pacific.

LITERATURE CITED

Agardh, J. G. 1876. Species, genera et ordines algarum. Vol. III. Epicrisis systematis floridearum, vii + 724. Leipzig.

Børgesen, F. 1915–20. The Marine Algae of the Danish West Indies, II. Dansk Bot. Arkiv, 3 : 1–504.

—— 1927. Marine Algae from the Canary Islands. III. Rhodophyceae. 1. Bangiales and Nemalionales. Kongel. Danske Vidensk. Selsk., Biol. Medd., 6 (6) : 1–97.

Butters, F. K. 1911. Notes on the Species of *Liagora* and *Galaxaura* of the Central Pacific. Minn. Bot. Stud., 4 (2) : 161–184, pl. 24.

Chou, R. C.-Y. 1945. Pacific Species of Galaxaura. I. Asexual Types. Pap. Mich. Acad. Sci., Arts, and Letters, 30 (1944) : 35–55.

Collins, F. S., and Hervey, A. B. 1917. The Algae of Bermuda. Proc. Am. Acad. Arts and Sci., 53 : 3–195.

De Toni, G. B. 1924. Sylloge algarum omnium hucusque cognitarum. Vol. IV, Sylloge floridearum: Additamenta, xi + 767, Patavii.

Ellis, J., and Solander, D. 1786. The Natural History of Many Curious and Uncommon Zoophytes Collected from Various Parts of the Globe, xii + 208, 63 pls.

Esper, E. J. C. 1830. Die Pflanzenthiere in Abbildungen nach der Natur mit Farben erleuchtet nebst Beschreibungen. Dritter Theil. Nürnberg.

Howe, M. A. 1920. Algae, pp. 553–618. *In* N. L. Britton and C. F. Millspaugh, The Bahama Flora, viii + 695. New York.

Kjellman, F. R. 1900. Om Floridé-slägtet *Galaxaura* dess organografi och systematik. Kongl. Svensk. Vetensk.-Akad. Handl., 33 (1) : 1–110, pls. 1–20.

Lamouroux, J. V. F. 1812. Zoophytes flexibles, ou coralligènes non entièrement pierreux. Nouveau Bulletin des Sciences, par la Société philomatique de Paris, 3 : 182–188.

—— 1816. Histoire des polypiers coralligènes flexibles, vulgairement nommés zoophytes, lxxxiv + 559, pls. 1–19.

Plukenet, L. 1691. Phytographia, pl. 168, fig. 4. London.

Tanaka, T. 1936. The Genus *Galaxaura* from Japan. Sci. Pap. Alg. Res., Fac. Sci., Hokkaido Imp. Univ., 1 (2) : 141–173, pls. 34–45.

Taylor, W. R. 1928. The Marine Algae of Florida with Special Reference to the Dry Tortugas. Pap. Tortugas Lab., Carnegie Inst. Wash., 25 : 1–219, pls. 1–37.

—— 1941. Tropical Marine Algae of the Arthur Schott Herbarium. Field Museum of Nat. Hist., Bot. Ser. 20, 4 : 87–104, pls. 1–2.

—— 1942. Caribbean Marine Algae of the Allan Hancock Expedition. The University of Southern California Publications Allan Hancock Atlantic Expedition, Report Number 2, p. 1–193, pls. 1–20.

—— 1945. Pacific Marine Algae of the Allan Hancock Expeditions to the Galapagos Islands. Allan Hancock Pacific Expeditions, 12 : iv + 528 (Chaetangiaceae, pp. 136–148).

Weber–van Bosse, A. 1921. Siboga-Expeditie. Liste des algues du Siboga. II, Rhodophyceae, première partie, Protoflorideae, Nemalionales, Cryptonemiales. Monographie LIXb de Uitkomsten op zoologisch, botanisch, oceanographisch en geologisch gebied verzameld in Nederlandsch Oost-Indië 1899–1900 aan boord H. M. "Siboga" onder commando van Luitenant ter zee 1e kl. G. F. Tydeman. Leiden.

Yendo, K. 1918. Notes on Algae new to Japan. VIII. Bot. Mag. Tokyo, 32 : 65–81.

EXPLANATION OF PLATE I

Galaxaura cylindrica

Fig. 1. Surface view of epidermis. × 340

Fig. 2. Section of portion of thallus. × 340

Figs. 3–4. Hypodermal and cortical cells. × 610

Figs. 5–6. Medullary filaments bearing cortical cells. × 340

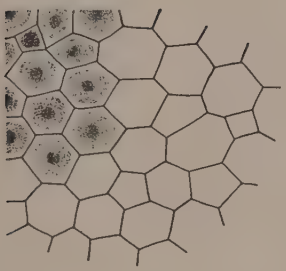
Figs. 7–8. Short free ends of filaments at fractured nodes. × 340

Fig. 9. Spermatangia with spermatia. × 610

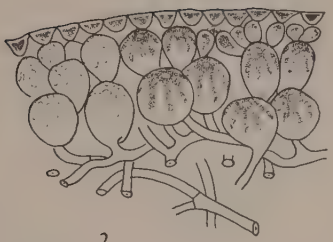
Fig. 10. Young branched filaments inside spermatangium. × 610

Fig. 11. Spermatangial branches, showing some spermatangia, with secondary or tertiary spermatangia developed within old walls. × 610

Fig. 12. Young spermatangia and young branching filament. × 610

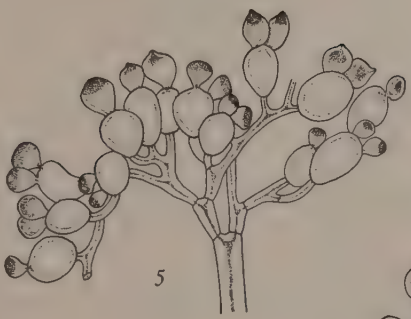


1

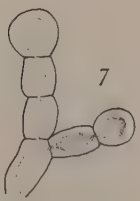


2

3

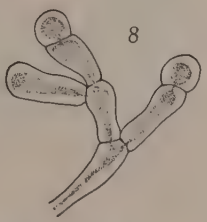


5



7

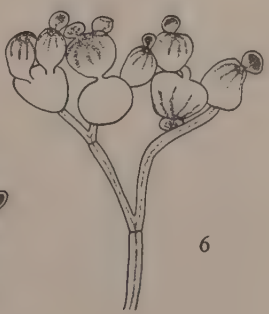
4



8

9

10



6

11

12

EXPLANATION OF PLATE II

Galaxaura oblongata

FIG. 1. Epidermis, surface view. × 340

FIGS. 2–4. Medullary filaments bearing cortical cells. × 340

FIG. 5. Habit of conceptacle removed from thallus. × 80

FIG. 6. Cluster of branching filaments inside the conceptacle. × 340

FIGS. 7–9. Sporogenous filaments with carposporangia. × 340

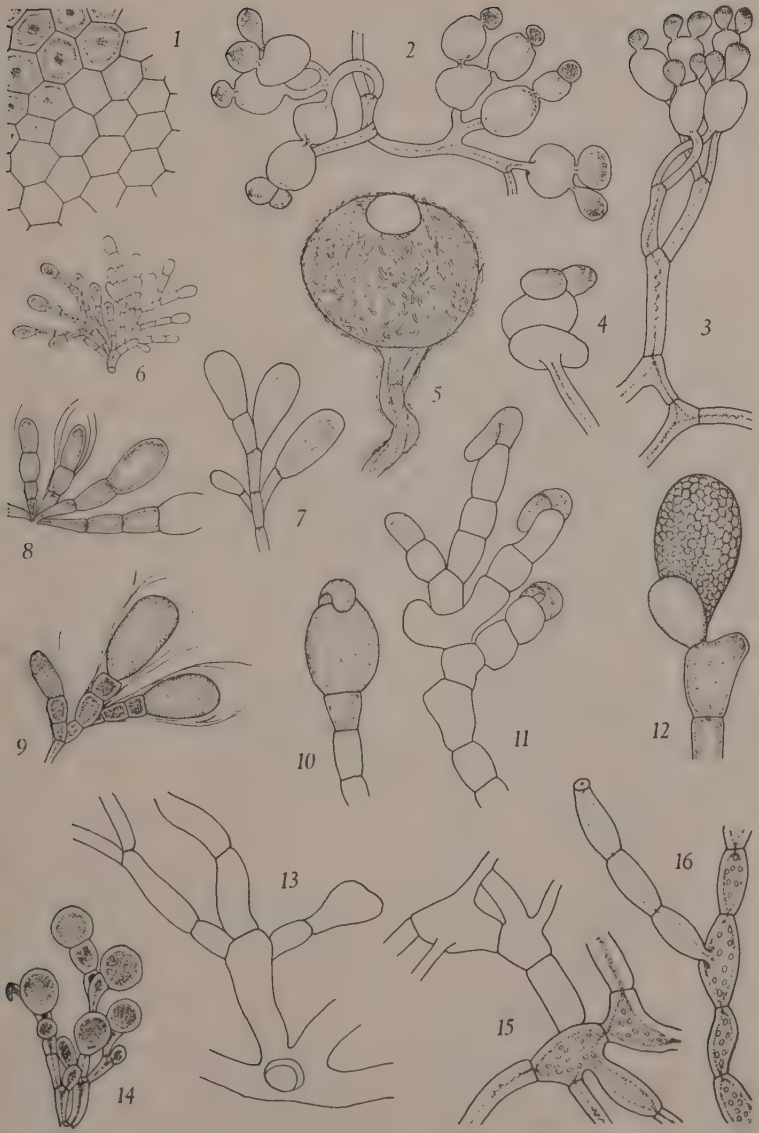
FIGS. 10 12. Hypertrophied carposporangial filaments containing starch grains. × 340

FIG. 13. Spermatangial filaments showing whorled branching. × 340

FIG. 14. Ultimate spermatangial filaments bearing spermatangia. × 610

FIG. 15. Medullary filaments with much enlarged cells containing starch grains at base of conceptacle. × 340

FIG. 16. Gonimoblast filaments at base of conceptacle. × 340


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

EXPLANATION OF PLATE III

Galaxaura oblongata

FIGS. 1, 14. Medullary filaments bearing cortical cells. × 340

FIG. 2. Regeneration of carposporangium. × 340

FIG. 3. Carposporangial filaments with young carposporangia. × 340

FIGS. 4–5. Carpospores showing variation in size. × 340

FIG. 6. Base of spermatangial filament with whorled branching. × 340

FIG. 7. Ultimate spermatangial filaments with spermatangia. × 610

FIG. 8. Ultimate spermatangial filaments with spermatangia. × 340

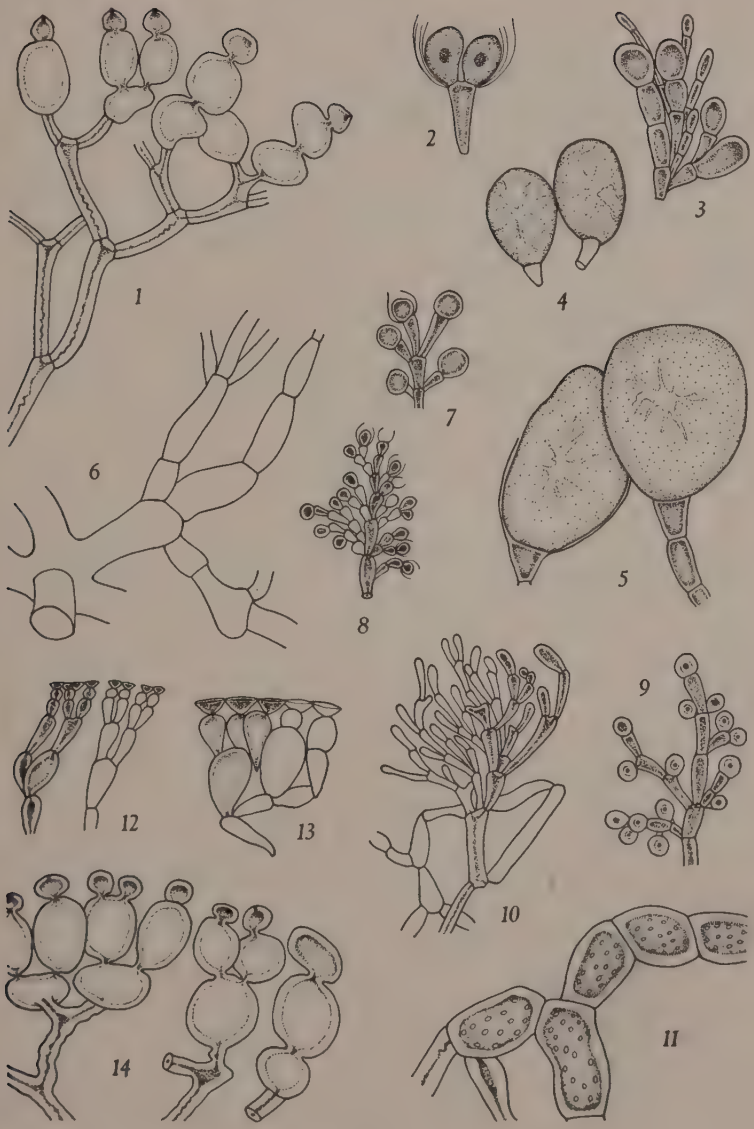
FIG. 9. Ultimate spermatangial filaments with young spermatangia. × 610

FIG. 10. Ultimate spermatangial filaments before spermatia are differentiated. × 340

FIG. 11. Gonimoblast filaments at base of female conceptacle. × 340

FIG. 12. Young vegetative filaments of apex of thallus. × 340

FIG. 13. Slightly older filaments below apex of thallus, showing development of cortical cells. × 340


1
2
3
4
5
6
7
8
9
10
11
12
13
14

EXPLANATION OF PLATE IV

Galaxaura squalida

FIGS. 1–2. Section of portion of thallus, showing cortical tissue and extended assimilatory filaments. × 225

FIG. 3. Epidermal cells, surface view. × 225

FIG. 4. Surface of epidermis, showing circular cells bearing extended assimilatory filaments. × 225

FIG. 5. Cystocarp (pericarp) longitudinal section. × 225

FIGS. 6–7. Gonimoblast filaments with carposporangial branches bearing carposporangia at the distal ends. × 225

FIGS. 8–9. Carpogonial branches bearing carpogonia. × 225

FIG. 10. Extended assimilator, showing branching. × 225

FIG. 11. Basal and terminal parts of extended assimilatory filament. × 225

Galaxaura rugosa

FIG. 12. Epidermis surface view, showing angular epidermal cells and circular cells bearing extended assimilatory filaments. × 225

FIG. 13. Section of portion of thallus. × 225

Galaxaura glabriuscula

FIG. 15. Epidermis, surface view. × 225

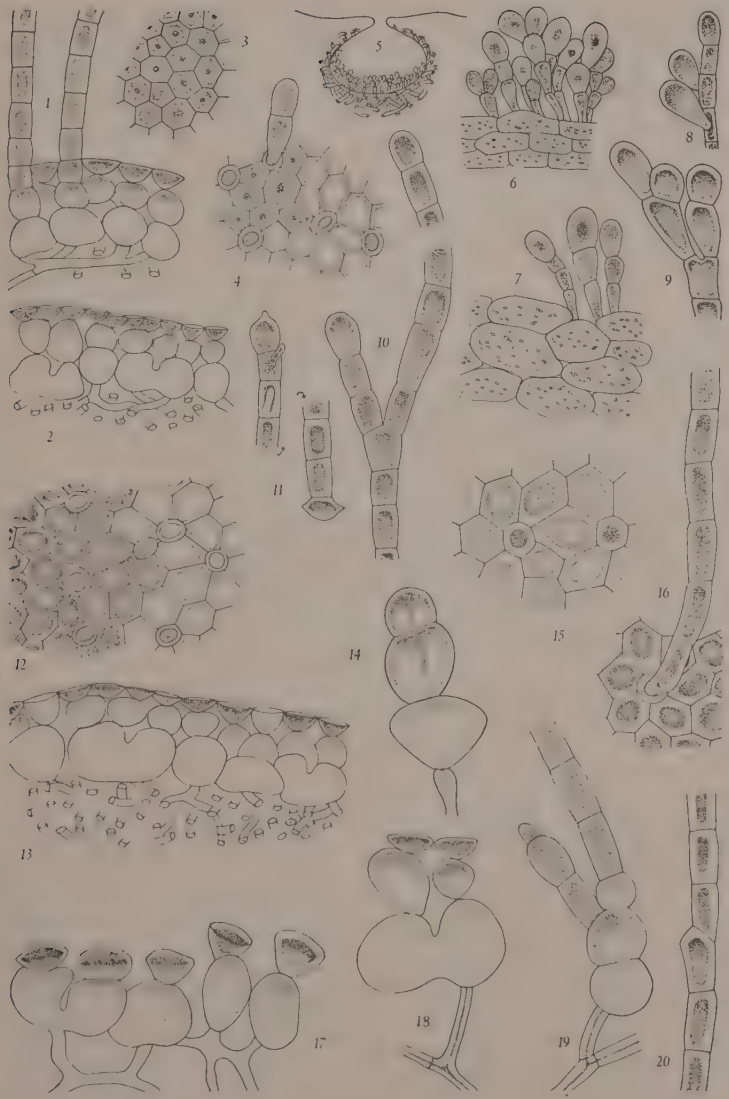
FIG. 16. Epidermis surface view, showing those circular cells among angular ones bearing extended assimilatory filaments. × 225

FIG. 17. Section of portion of thallus. × 225

FIGS. 14, 18. Cortical cells in relation to medullary filaments. × 225

FIG. 19. Extended assimilatory filaments in relation to cortical cells and medullary filaments. × 225

FIG. 20. Upper portion of extended assimilator, showing possible branching. × 225


1
3
5
6
8
4
9
7
2
10
11
12
14
15
16
13
17
18
19
20

EXPLANATION OF PLATE V

Galaxaura umbellata

FIG. 1. Section of portion of older thallus. × 340

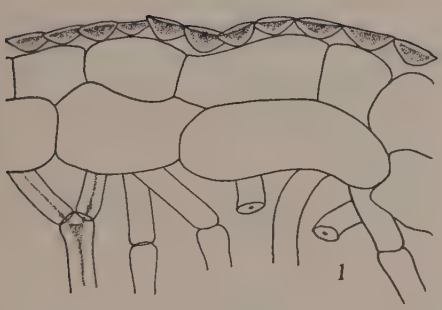
FIG. 2. Surface view of epidermis. × 340

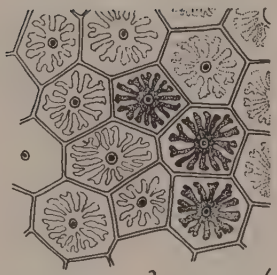
FIG. 3. Habit of part of plant. × 1

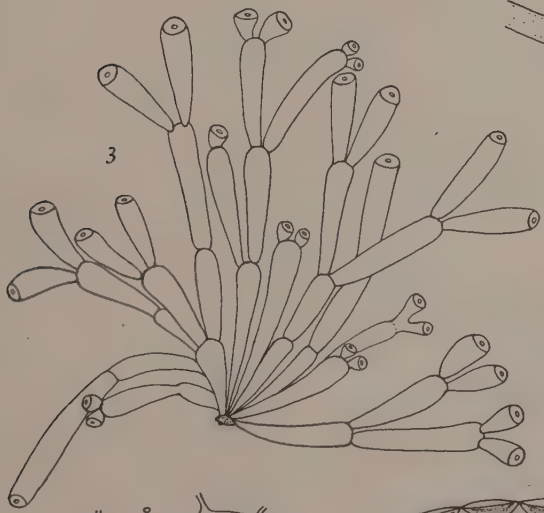
FIG. 4. Medullary filament. × 340

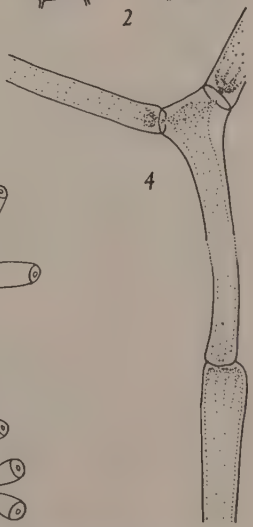
FIG. 5. Surface view of hypodermal layer of cells (intermediate layer of cortex), showing stellate chromatophores. × 340

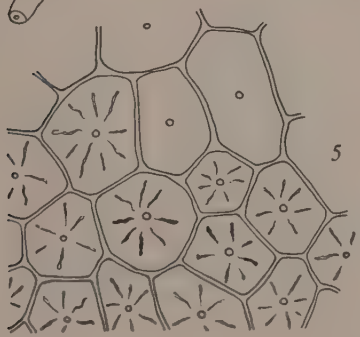
FIG. 6. Section of portion of young thallus. × 340

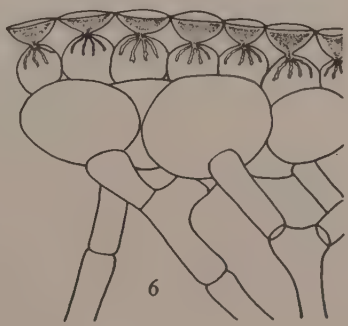

1


2


3


4


5


6

EXPLANATION OF PLATE VI

Galaxaura veprecula

FIG. 1. Section of portion of thallus, showing epidermal cells bearing spinulose cells. × 340

FIG. 2. Section of portion of thallus without spinulose cells. × 340

FIG. 3. Extended assimilatory filament on the base of proliferation. × 195

FIG. 4. Surface view of epidermis. × 340

FIG. 5. Antheridial branch bearing spermatangia. × 340

FIG. 6. Two carposporangia. × 340

FIG. 7. Young secondary carposporangia with sheaths of old carposporangial walls. × 340

FIG. 8. Older stage of carposporangial branch with carposporangia. × 340

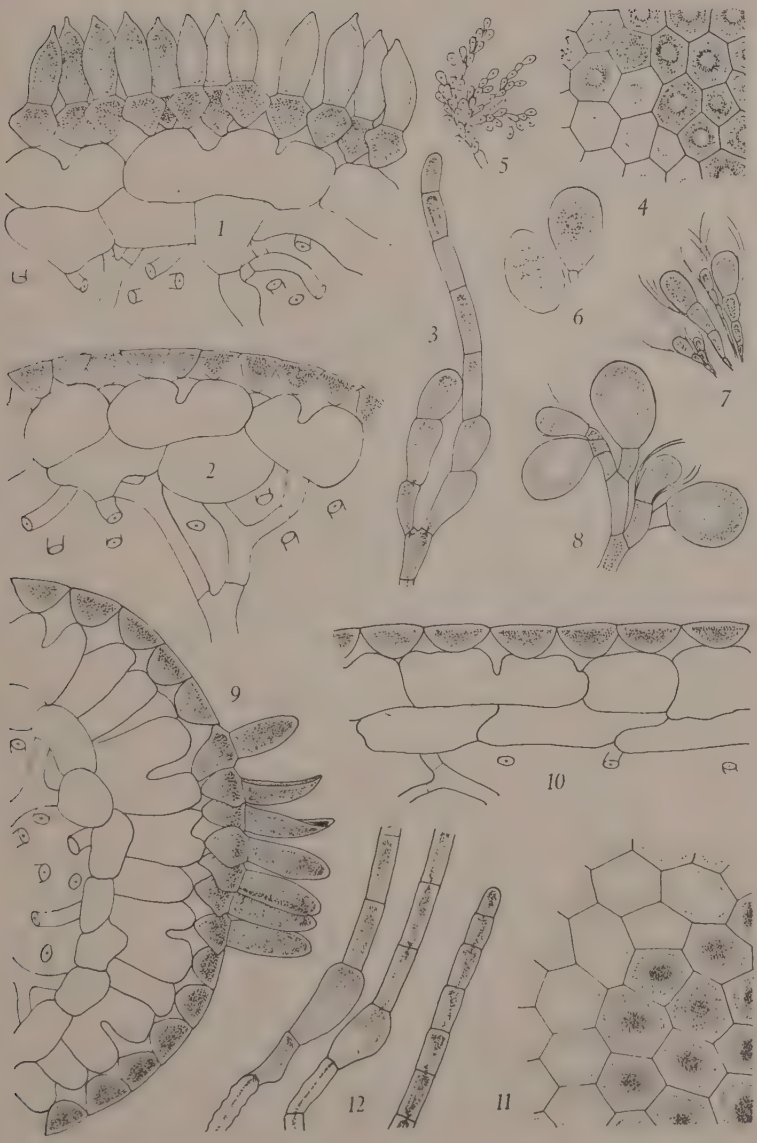
Galaxaura ventricosa

FIG. 9. Transverse section of thickened margin of thallus. × 195

FIG. 10. Section of portion of flattened side of thallus. × 340

FIG. 11. Surface view of epidermis. × 340

FIG. 12. Extended assimilatory filaments at the base of proliferations. × 195


1
2
3
4
5
6
7
8
9
10
11
12

EXPLANATION OF PLATE VII

Galaxaura angustifrons

FIGS. 1–2. Section of portion of thallus. × 340

FIG. 3. Surface view of epidermis. × 340

FIG. 4. Extended assimilatory filaments. × 340

FIG. 5. Young extended assimilatory filaments. × 340

Galaxaura intermedia, sp. nov.

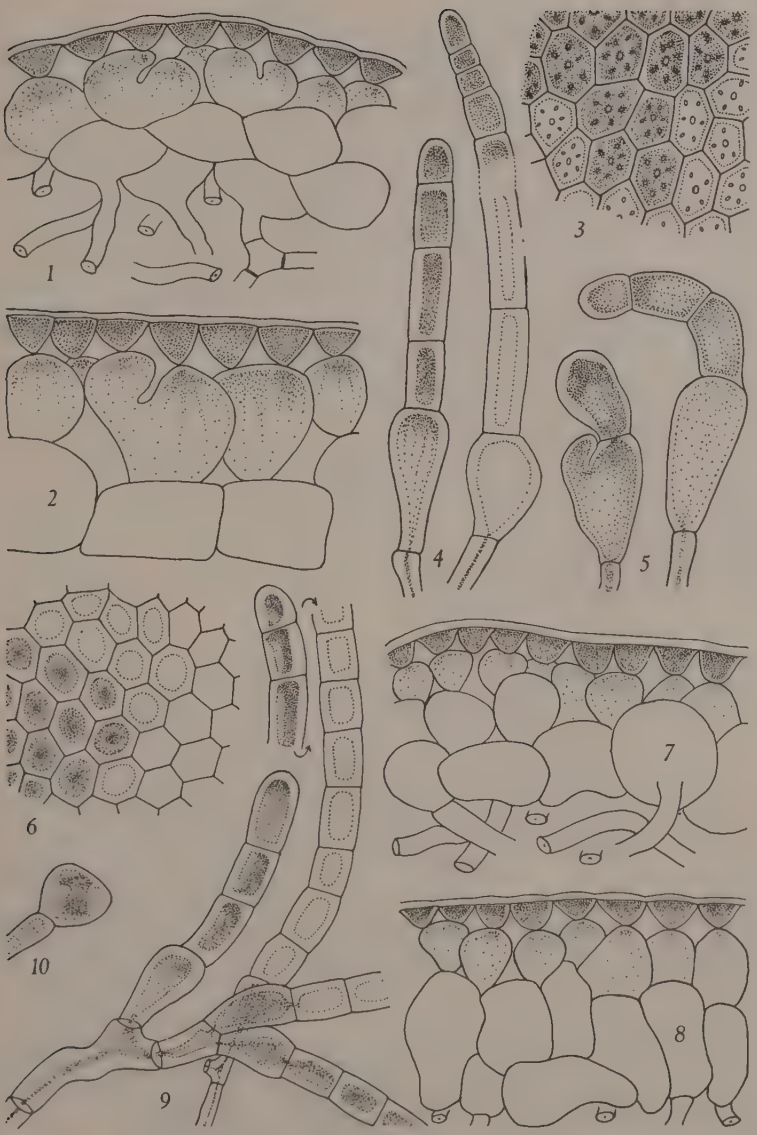
FIG. 6. Surface view of epidermis. × 340

FIG. 7. Section of portion of thallus. × 340

FIG. 8. Section of portion of thallus at the thickened margin. × 340

FIG. 9. Extended assimilatory filaments. × 340

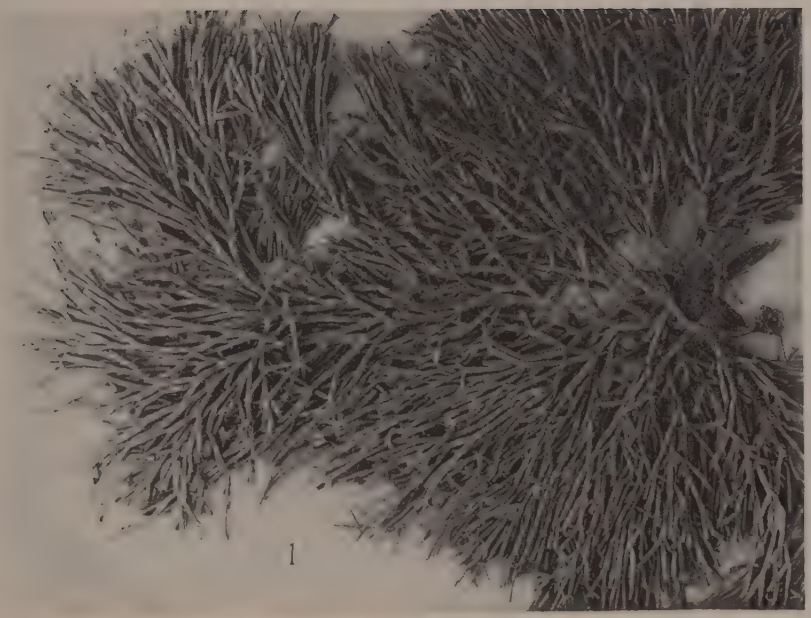
FIG. 10. Young developing extended assimilatory filament. × 340


1
2
3
4
5
6
7
8
9
10

EXPLANATION OF PLATE VIII

FIG. 1. *Galaxaura cylindrica: Bartlett 14981,* Dalupiri Island, Babuyan Group, P. I. × 1

FIG. 2. *Galaxaura squalida; Villaflores 6, 8,* Mindoro Province. P. I. × 1.1



1

2

EXPLANATION OF PLATE IX

FIG. 1. *Galaxaura oblongata*, male plant; *Bartlett 16185*, Liloan Beach, Cebu Island, P. I. × 1.1

FIG. 2. *Galaxaura oblongata*, female plant; *Bartlett 14980*, Dalupiri Island, Babuyan Group, P. I. × 1

1

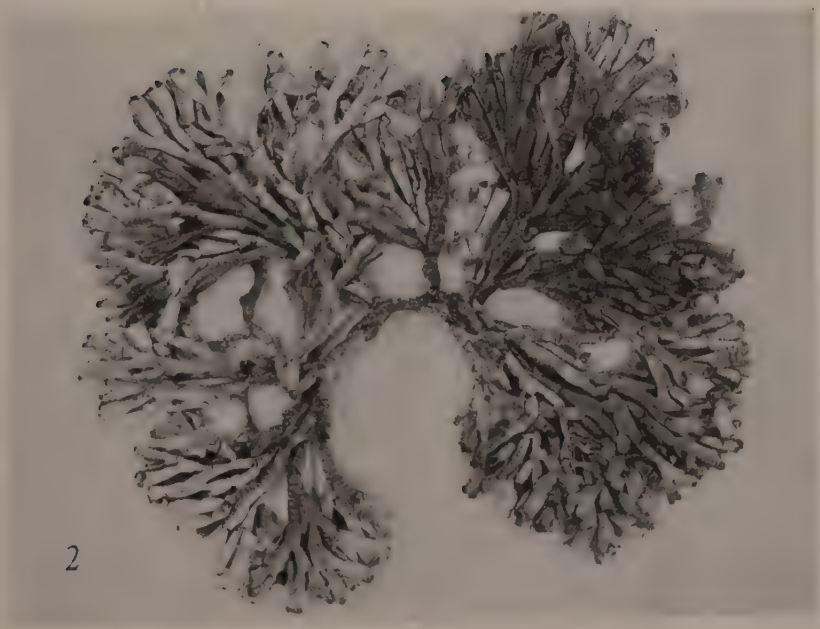
2

EXPLANATION OF PLATE X

FIG. 1. *Galaxaura glabriuscula; Kostermans 254*, Eiland Kĕlapa, Duizend-eilanden, Java. × 1.2

FIG. 2. *Galaxaura rugosa; Bartlett 15410*, Batan Island, P. I. × 1.3

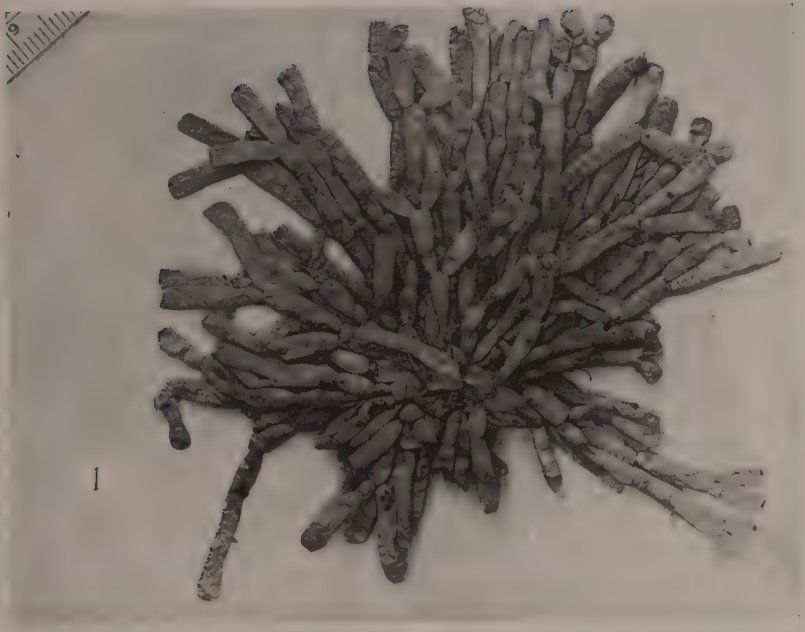
1


2

EXPLANATION OF PLATE XI

FIG. 1. *Galaxaura umbellata; Bartlett 15022*, Dalupiri Island, Babuyan Group, P. I. × 1.25

FIG. 2. *Galaxaura angustifrons; Taylor 81–33*, Isla Santa Cruz, Ecuador. × 1.5



1

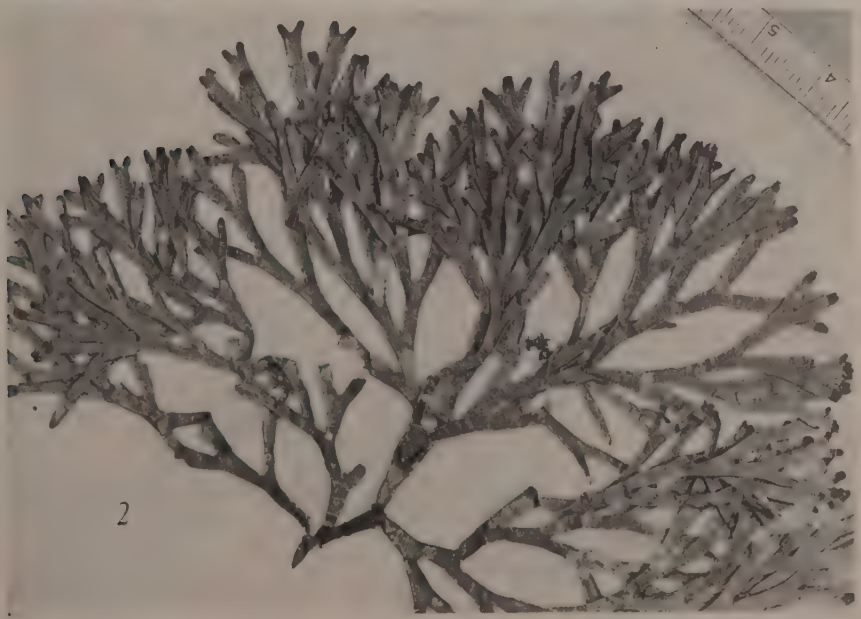
2

EXPLANATION OF PLATE XII

FIG. 1. *Galaxaura veprecula: Bartlett 15009b*, Dalupiri Island, Babuyan Group, P. I. × 1

FIG. 2. *Galaxaura ventricosa: Taylor 39-652*, Isla María Magdalena, Mexico. × 1

1


2

EXPLANATION OF PLATE XIII

Galaxaura intermedia Chou, sp. nov.; *Taylor 34–213* (TYPE), Isla Santa María, Galápagos Islands, Ecuador. × 0.75

OBSERVATIONS ON THE HABITS OF SOME OF THE NATIVE PLANTS OF KALAMAZOO COUNTY, MICHIGAN

CLARENCE R. HANES

THE observations on the habits of the plants reviewed in this paper were carried on from 1934 through 1944 by Mrs. Florence N. Hanes and the writer. In 1944 especially we made an intensive exploration in several of the lakes of the county. The plants studied are mainly aquatic species — those growing in a few inches or several feet of water or on the shores of ponds and lakes or on the beds of the ponds during the seasons when they have become partly or completely dry.

Many of the water plants have various means of reproduction other than by seed. They have different forms of tubers or rootstalks, as do some of the genus Potamogeton. They may be broken up by wind or dislodged by fishermen, and these separated parts may take root and make new plants. *Cabomba caroliniana* is an example. *Myriophyllum heterophyllum* sends out new shoots from the blossom spike, and others of the Myriophylla produce winter buds along the stems. Compact or loose leafy buds of some of the Utricullariae pass the winter on the bottom of pond or lake.

Whether a plant should be classed as "rare," "infrequent," or "common" in a given territory should depend upon how thoroughly the territory has been botanized throughout several growing seasons. Also, before a verdict is given one ought to be familiar with the same plant both when it is in the flowering state and when merely the sterile form is to be seen. Some of the water plants blossom only occasionally, and even when they do the inflorescence may be so inconspicuous that it can be overlooked.

In 1941 we found many specimens of *Potamogeton Robbinsii* Oakes on the shore or in the shallow water of Austin Lake. For a number of years prior to this date we had visited the lake but had never seen any of this pondweed. During 1942, 1943, and 1944 there was no

reappearance, at least near the shores. Apparently *P. Robbinsii* has at intervals its seasons of abundance.

Scheuchzeria palustris L. var. *americana* Fern. is a plant of sphagnous bogs. The only station known to us in Kalamazoo County is in an extensive bog in Section 28, Portage Township. Here on June 27, 1940, standing in one place we were able to count 100 of these plants and in another place 125 of them. All were in fruit. On June 29, 1941, after an extended search over the same ground where so many fruiting plants had been found the previous year, only one in fruit was discovered. This did not mean that there were none of these plants present, since we saw plenty of their grasslike leaves. The leaves can be mistaken for those of grasses, sedges, or rushes, but close inspection will reveal the tiny opening at their tips which is a diagnostic character of the species. The apparent rarity of the plant may therefore be due partly to its capricious fruiting habits.

Scirpus subterminalis Torr. is considered by some botanists to be of infrequent occurrence. Our first introduction to the species was through the collection of a mass of plant refuse dislodged by wind and deposited on the shore of Pawpaw Lake. When this was studied at home, specimens of *S. subterminalis* were found mingled with other aquatic flora. The following year (1939) beds of this plant were seen at Pawpaw Lake in about two feet of water. They extended a few yards offshore, for a distance of several rods. Only a portion of the beds sent up fruiting culms, the rest consisting of plants with the fine sterile leaves. Later this species was found in Barton, Stony, and Thrall lakes. During 1944, when a survey was made in several of our county lakes, beds of *S. subterminalis* were discovered in Blue, Eagle, Mud (Portage Township), Pickerel, and Weeds lakes. In Weeds Lake and in parts of Eagle Lake the beds were extensive and showed signs of fruiting, but in the other three merely the sterile leaves were seen. These leaves, when covered with a marly deposit, are rather drab and may be thought to be filaments of algae. They are cellular and channeled and are not often more than four to six decimeters in length. Sometimes they grow at depths of five feet. The fertile culms, which are larger, apparently do not always produce spikelets, since we have examined many before getting one with the inconspicuous fruiting part.

Scirpus fluviatilis (Torr.) Gray is frequent in the western half of the county on lake and pond borders and in the shallow water in such

places. When the water level becomes too high, this sedge may entirely disappear until conditions again become favorable. At most of the stations known to us, however, it is found in the same places year after year. When in anthesis it is a very noticeable plant, with many spreading rays to each showy umbel, but in our county fruiting is erratic or almost absent over a period of years. We have never seen a blossom among several stands of these plants, although the culms have always been robust. We saw more fruiting in 1938 than at any time before or since. The beds at Twin Lakes, Alamo Township, appear to be exceptional in that they were in flower in 1941 and again in 1942.

Eleocharis Robbinsii Oakes is reported in Deam's *Flora of Indiana*[1] from only two counties, which are in the northeastern part of that state. Until recently it was considered rare in Michigan also, but field work during the past decade has shown new stations until now we have reports from Allegan, Cass, Kalamazoo, Kent, Presque Isle, and St. Joseph counties in the Lower Peninsula and from Alger County in the Upper Peninsula.

In Kalamazoo County we have found it in small numbers at Austin, Pickerel, and Stony lakes and in abundance at Eagle, Pine Island, and Thrall lakes. In 1941 a swamp east of Gourdneck Lake, which became dry during that year, had its borders covered with this sedge. In swamps southwest of West Lake it was also extremely common. In 1944 at Weeds Lake in Texas Township this species was found on the shores and in shallow water. On floating islands in the lake pure stands of it made yellowish-green carpets.

This sedge grows in the shallower parts of ponds and lakes, but thrives best on soil from which the water has recently receded. It has slender rootstalks, and some new plants are developed from these as the colonies are very dense. It is apparently shy about fruiting during most seasons. The spikelet is quite inconspicuous in flower, and in fruit it has a ragged appearance, as if it had been injured or gnawed. Our own experience shows that it can easily be overlooked. For several years prior to 1938, when we discovered our first specimens, we had waded in the shallow water of a pond where hundreds of this species normally grow without becoming aware of their importance.

Those familiar with *Eleocharis rostellata* Torr. know that many of

[1] Deam, C. C., *Flora of Indiana* (Indianapolis, 1940), p. 200.

the sterile culms take root at the tips. Walking through a grassy swamp where this sedge grows, one is made aware of its presence by hearing the steady snapping as the culms fastened at both ends are broken loose.

Unlike *Eleocharis rostellata*, *E. melanocarpa* Torr. roots mainly at the tips of the fertile culms, or at least its first rooting occurs at the base of the spikelets, and under the right conditions it takes place soon after the achenes are ripe. As many as ten plants may come from a like number of tips. This early prolification usually begins the last of July or the first of August. When these newer plants are well grown, some of them may produce others from what might now be considered sterile culms. This is noticeable in the middle of September, at which time the parent plant and its first and second progeny are all tied together.

We have specimens with the small roots growing from the base of the spikelet before the spikelet has begun to shed its scales and achenes. We have observed this habit of *Eleocharis melanocarpa* at Eagle and Pretty lakes in Texas Township, especially in plants growing in the sand near or on the margins of the lakes. Here the plants have not been crowded by other vegetation. At Austin Lake, where the culms are more densely tufted and grow in less sandy soil and are associated with a ranker floral growth, this species is less proliferous. Whatever young plants are produced do not begin to develop before September. In 1944 late development was also observed at Eagle Lake in situations where the conditions were similar to those at Austin Lake.

Rhynchospora macrostachya Torr., an Atlantic Coastal Plain species, is frequent in the southwestern part of the county. Acres of it have been seen in shallow water at Crooked Lake. When the "Island" pond west of the village of Schoolcraft is nearly dry, a good stand appears, but for the past few years, with water four or five feet deep, no plants have been observed. Elsewhere periods of high water have reduced the number of this species to a minimum.

Rhynchospora fusca (L.) Ait. f. has been discovered at only one site in Kalamazoo County. This sedge is mostly near the Atlantic Coastal Plain. According to a map showing the distribution of *R. fusca* in the United States and Canada,[2] our station is the farthest south of

[2] Gale, Shirley, "Rhynchospora, Section Eurhynchospora, in Canada, the United States and the West Indies," *Rhodora*, 46: 132. 1944.

those in the interior of the country. It is in a pond or marsh southwest of West Lake. During 1938–41 there were scattered masses of this stoloniferous plant growing in the peat moss. Later, with water covering the site to a depth of two to three feet, no traces were seen of it until the fall of 1944. By that time the pond had dried away, and once more one could walk over the ground. Plants again formed carpets of rusty hue, but evaporation had occurred so late that only a few achenes were produced. Another dry season will, no doubt, show an abundance of fruiting plants. The growth now appears to occupy the same relative positions that it did during 1938–41. Apparently, while the water had covered the area, no new beds had formed nearer the shores.

Lemna valdiviana Philippi is a Lemna about which we know very little. It is included in this paper partly because our discovery of it is a new record for the state. Professor M. L. Fernald, who confirmed our determination, knew of no other report from Michigan. We found it on November 24, 1943, in shallow water near Fox and Beers' mill in Section 26, Prairie Ronde Township. A dish of aquatic plant material was collected; when we examined it at home we discovered many specimens of *L. valdiviana* associated with *L. minor*, *L. trisulca*, and *Wolffia columbiana*. Again, on November 4, 1944, we gathered material from the same pond, but were able to distinguish only a very few plants of this species in it.

Myriophyllum tenellum Bigel., unlike the other Myriophylla, is almost leafless. It is a small plant with a scape usually less than one millimeter in diameter and about one decimeter high. Horizontal creeping rootstalks buried two centimeters or more in the sand may send up as many as ten plants. Half of these may be fertile. All that we have observed have been in very shallow water adjacent to the shore. Often some of the plants are on the shore where wave action can moisten them.

We first collected specimens on the east and south shores of Eagle Lake in September, 1934, and August, 1935. Later we found masses several yards in extent at Pretty Lake. In 1936 plants were abundant at these two lakes, but during the seasons from 1937 through 1940, when the water in the lakes was high, none were seen. In 1941 it reappeared in small numbers, but in 1943 and 1944 it had again vanished. It was during these years that the lakes extended their shorelines several rods inland.

Some texts state that this species is usually submersed. At least when in anthesis the spikelet must be emersed. Whether plants can persist in more than a foot of water for long periods without blossoming is unknown to us. Then they would be difficult to locate, since they might not be matted in beds, as they are when the water is very shallow.

Myriophyllum tenellum is not at all common in the state. At one time it was considered very rare, but collections in recent years by the Institute for Fisheries Research have shown a wider distribution, especially in the Upper Peninsula and from Kent County northward in the Lower Peninsula. Records from ten Michigan counties, sent to us by Mrs. Betty R. Clarke from the University Herbarium, place our stations at Eagle and Pretty lakes farther south than any others yet reported.

On August 5, 1936, we made our first discovery of *Lindernia anagallidea* (Michx.) Pennell (*Ilysanthes anagallidea* of *Gray's Manual*, Seventh Edition). This was in a pond a short distance east of Gourdneck Lake. The pond is alternately almost dry or filled with water to varying depths. The year 1936 was at the end of several dry years. The plants were in mud and lay spread out, so that the largest occupied a space of a square foot. There were one rather heavy root and a few smaller ones to each plant. The several main stems had branches which, in turn, bore small branchlets. The main fruiting branches produced about 100 flowers each and the whole plant at least 600.

On August 19, 1937, the pond had begun to fill up. Where the spreading plants had been discovered the previous year a few were located in six or seven inches of water. These had many fibrous roots, but not more than 8 flowers to a stem and fewer than 25 to a plant. The stems were erect and not branched. During 1941 the water receded again, but no plants were seen. For the three years 1942 through 1944 the pond has had several feet of water, so that there has been little opportunity to rediscover this species. We have collected it only at this station. It appears to be rare in our state.

During periods of high water we have found only a small percentage of the plants of *Utricularia resupinata* B. D. Greene that we have seen after several dry seasons. The specific name of *Lycopodium inundatum* L. shows that this plant must be sometimes expected to be under water. At the few stations where we have been fortunate to

find it, water has completely covered it since 1942. On the other hand, high-water levels bring to life again plants that apparently have been nonexistent for many years. Their habitats may become so desiccated that they or their seed remain dormant. *Scirpus Smithii* Gray has been discovered where it was not known to exist, and cattails — both the broad-leaved and the narrow-leaved species — were seen in 1944 in a field that had been continually cropped for more than a decade.

Schoolcraft, Michigan

THE BRYOPHYTE FLORA OF MICHIGAN *

WILLIAM CAMPBELL STEERE †

THE bryophyte flora of Michigan has been so intensively collected and studied during the last thirty-five years that it has come to be among the largest and best known in the United States. It is now difficult to realize or even to believe that Michigan bryology was an almost totally unknown phase of botany near the turn of the century.

The exhaustive studies in Ohio by Sullivant, Lesquereux, and other early bryologists apparently led them to the erroneous assumption that the bryophyte floras of Michigan and Ohio were more or less identical. Consequently, they encouraged their botanical correspondents to collect bryophytes in more distant states, with the result that, although specimens from Wisconsin, Minnesota, and Illinois are frequently cited in such standard earlier works as Lesquereux's "Supplement" to Sullivant's *Icones Muscorum* (1874), Lesquereux and James' *Manual of the Mosses of North America* (1884), and Underwood's *Descriptive Catalogue of the North American Hepaticae, North of Mexico* (1884), Michigan is never mentioned.

It is surprising that many of the early publications dealing with Michigan bryophytes are based on collections made in the more inaccessible parts of the state. Sprague's report (1858) of *Neckera pennata*, collected on Keweenaw Point by Dr. Thomas Kneeland, is apparently the first published record of a Michigan moss, and Austin's description (1872) of a new species, *Jungermannia Gillmani*, marks the first report of a Michigan hepatic. This species, now known as *Leiocolea Gillmani* (Evans and Nichols, 1935), was first collected on Au Train Island, in Alger County, by Henry Gillman, who later re-

* Contribution from the Department of Botany, the Herbarium, and the Biological Station of the University of Michigan.

† I wish to acknowledge here my obligation to several grants-in-aid from the Faculty Research Fund and from the Horace H. Rackham School of Graduate Studies of the University of Michigan, which have made possible much of my field work outlined in this paper.

ported *Preissia quadrata* from Huron County in the "Thumb" district and from several other localities (1876).

The reports on Michigan bryophytes fall clearly into two general classes: (1) casual or incidental mention of a few species in floristic or ecological researches; and (2) lists of species based on the special study of a specific collection or region. The first class is especially well illustrated by the several publications on the vegetation of northern Michigan by E. J. Hill (1885, 1886, 1900, 1902, 1905, 1909). A search of his articles has turned up references to *Dicranum scoparium*, *D. undulatum*, "*Trematodon longicollis*," "*Rhabdoweisia fujax*," *Mnium marginatum*, and *Cratoneuron filicinum* from the Menominee iron region (1885); *Marchantia polymorpha* from the White Lake region, Muskegon County (1900); *Encalypta procera*, *Distichium capillaceum*, and *Myurella Careyana* from Presque Isle, Marquette County (1905); and *Dicranum fuscescens* (1886), *Amblystegium noterophilum* (1909), and *Fissidens grandifrons* (1902, 1909) from Boyne Falls, Charlevoix County. *Mnium rostratum* and *Polytrichum strictum* were reported anonymously in 1900 [Smith] from collections made by C. K. Dodge. In 1904 F. P. Daniels referred to *Marchantia polymorpha*, *Conocephalum conicum*, *Preissia quadrata*, *Riccia fluitans*, and *Ricciocarpus natans* in a paper on the flora of Manistee, and to *Marchantia polymorpha*, *Riccia fluitans*, and *Ricciocarpus natans* in an ecological study of the vicinity of Sturgis, in St. Joseph County. *Ditrichum giganteum*, first collected in the Yukon by Williams, was ascribed to Michigan by Mrs. Britton (1913a), but the specimen referred to cannot be found at the New York Botanical Garden, and the species does not seem to have been collected again in the state. The Michigan report of *Blindia acuta* (Britton, 1913b), however, has been confirmed. In a list of plants inhabiting ravines near Adrian (Lenawee County) F. L. Stearns (1905) tabulated Mnium, Funaria, Aulacomnium, Bartramia, and Conocephalum as "characteristic mesophytic herbs." Since there is no ambiguity concerning the species meant (cf. Steere, 1933b), we may include these reports without question as *Mnium cuspidatum*, *Funaria hygrometrica*, *Aulacomnium heterostichum*, *Bartramia pomiformis*, and *Conocephalum conicum*. The last incidental reference to be included here is the mention by Gates (1912) of *Marchantia polymorpha* in an ecological study of Cheboygan County.

The more strictly bryological researches making up the second

category may be subdivided on a geographical basis, depending on whether they concern themselves with the Upper or the Lower Peninsula of Michigan.

I. THE LOWER PENINSULA

The first substantial published list of Michigan mosses was based on a collection made during October and November of 1891 by A. Purpus, in the vicinity of Clarklake (Jackson County), in the southern part of the Lower Peninsula. Dr. Julius Röll, a well-known German bryologist, made a botanical collecting trip across the United States in 1888. He inspired many of his countrymen here to collect for him, which explains why the Purpus collection went to Germany for study. In a report covering several collections made in a number of states Röll (1897) listed 70 species of mosses and 9 species of Sphagnum collected by Purpus at Clarklake, as well as 3 species of Sphagnum sent from Opeechee (Keweenaw County) by Bollmann, another correspondent. Unfortunately, Röll submitted many of his specimens for identification to N. C. Kindberg, a notoriously undependable bryologist, who usually found it much easier to manufacture new species than to identify specimens with known species (Steere, 1939b). In Röll's list we find reports of several species whose existence in southern Michigan is highly improbable, especially *Entodon orthocarpus* (LaPyl.) Lindb. (as *Cylindrothecium concinnum* Sch.) and *Brotherella Roellii* (Ren. & Card.) Fleisch. (as Raphidostegium). I am quite certain that the report of the Entodon is based on *Pleurozium Schreberi*, which resembles it very closely in superficial appearance. As the Pleurozium is abundant in the region and is commonly associated with many of the other species reported, my certainty is justified. *Brotherella Roellii* is known only from Washington and British Columbia, but it is not easy to guess which Michigan species was so named, without seeing the actual specimen. The report of *Homalothecella subcapillata* (Hedw.) Card. (as *Platygyrium brachyclados*) is likewise open to considerable doubt, and this species should not be included as a member of the Michigan flora until we have specimens upon which to base the record. The single "new species" proposed by Kindberg, *Hypnum* (*Campylium*) *sinuolatum*, has already been placed in synonymy by Grout (1928–40), who saw the type specimen and referred it to *Campylium chrysophyllum*.

It is unfortunate that Röll's paper has been completely overlooked by Nichols, myself, and all other students of Michigan bryology until very recently, when I came across it quite by accident during the course of a routine search of bryological literature. This oversight was caused not only by the fact that the paper was published in a German publication (*Hedwigia*) covering all groups of crypotogams, but also because the specimens are not represented in any American herbarium. If the Purpus collection had been known, Röll's report might have been looked for. With the exception of the few species already discussed, all those of Röll's list have been discovered since and reported from other localities in Michigan.

In 1915 Kauffman published a list of 105 species of mosses and 26 species of hepatics which he and his students had collected in the southern part of the state. Except for his report of *Thamnium alleghaniense*, based on *Climacium dendroides* (Steere, 1934a), all his identifications have been confirmed through a study of his specimens or by later collections of the same species. In 1926 I became interested in the bryophytes of the Ann Arbor region and began to collect and study them. This investigation led to the discovery of a number of species not reported by Kauffman and, eventually, to the publication of several articles (Steere, 1931a, 1931b, 1933a, 1933b). My first list added 50 species to Kauffman's, and 18 to the flora of the state, whereas the supplement recorded 9 species for southern Michigan and 2 for the state. The important collections made in Kalamazoo County by H. R. Becker have added many species of great interest to the flora of the state (Nichols, 1932, 1933; Nichols and Steere, 1936) and one species new to science (*Buxbaumia cylindrica* Grout). Continued work in the Ann Arbor region has resulted in more additions to the flora of Michigan, which have been reported recently (Steere, 1942).

The bryophytes of the northern half of the Lower Peninsula have been studied with special intensity in the vicinity of the University of Michigan Biological Station, at Douglas Lake, Cheboygan County. The first bryological contribution from the station was a list of 10 species of Sphagnum reported by Praeger (1919), who had been stimulated to collect them by G. E. Nichols, at that time an authority on the use of Sphagnum in surgical dressings for World War I. Dr. Nichols joined the staff of the Biological Station in 1920, and in 1922 published the results of his bryological investigations during his

first two summers at Douglas Lake, in the form of a list of 261 species, of which no fewer than 101 were reported as new to the flora of Michigan (Nichols, 1922). Subsequent investigations during the next four summers resulted in a supplementary publication (Nichols, 1925), which added 14 more species to the state. He continued his collecting in the Douglas Lake region through the summer of 1938 and reported new records from time to time (Nichols and Steere, 1936). My connection with the Biological Station, beginning with the summer of 1939, has led to the addition of a number of species to Cheboygan, Emmet, and Presque Isle counties and to the flora of the state (Steere, 1942), and Darlington's collections from Leleenau County (1938) have further increased our knowledge of the wider distribution of bryophytes in the northern part of the Lower Peninsula. A paper by Irma Schnooberger (1940), on the bryophytes of the central part of the Lower Peninsula, is of unusual interest since in the area covered we find the boundary between the hardwood forest flora of the south and the mixed coniferous forests of the north.

II. THE UPPER PENINSULA

Collections from the Upper Peninsula are of two origins: (1) those from Isle Royale, and (2) those from the mainland. Isle Royale has received a remarkable amount of attention from botanists, in spite of its remoteness, so that its bryological flora is now better known than that of many other parts of the state which are much more accessible. In 1909 Holt published a list of 38 mosses which had been collected during an ecological study of Isle Royale. Cooper's papers (1912, 1913), likewise the result of an ecological study, raised the number of mosses known from Isle Royale to 104 species, and were soon followed by Conklin's report (1914) of 36 species of Hepaticae. Thus, within a period of five years, the northernmost and most inaccessible region of Michigan became the best known from a bryological viewpoint. Much more recently a thorough botanical survey of Isle Royale has greatly increased the known species, which now number 53 hepatics and 208 mosses (Thorpe and Povah, 1935). A few casual collections have added still other species (Cooper, 1928; Steere, 1942).

With the exception of a few species of somewhat doubtful identification (Povah, 1929), the bryophyte flora of the Upper Peninsula

between Isle Royale and Mackinac Island was practically unknown until the summer of 1933, when Nichols and I started field work there independently. My work in the Upper Peninsula began with a month's investigation (June, 1933) of the bryophytes of the Chase S. Osborn Preserve of the University of Michigan, on Sugar Island in St. Mary's River (Chippewa County) (Steere, 1943b). Much of July was spent in Alger County, both at the Pictured Rocks near Munising and in the vicinity of Au Train, and a brief trip was taken to the Keweenaw Peninsula. The Pictured Rocks were visited by Nichols in August, 1933, and a large number of species new to Michigan were collected by us (Nichols, 1933; Steere, 1934a), as well as one new species, *Barbula michiganensis* Steere (in Grout, 1928–40; Steere, 1939b).

During the summer of 1934 Nichols began a bryological investigation of the Huron Mountains in Marquette County (Nichols, 1935), which he continued during the summers of 1936 and 1937 (Nichols, 1938), and during the same summer I made extensive collections in Delta and Alger counties (Steere, 1934c). In 1935 Nichols and I started field work together in a survey of the Porcupine Mountains of Ontonagon County, which resulted in joint publication (Nichols and Steere, 1936, 1937). Earlier in 1934 I made an intensive study of the bryophytes of the Keweenaw Peninsula, which I had previously visited very briefly during 1933 (Steere, 1934a). A whole group of Rocky Mountain and Pacific Coast bryophytes of unusual significance was discovered (Steere, 1937), and further work in the same region during 1936 and 1937 led to the accumulation of more information on the distribution of these "critical" bryophytes (Steere, 1938, 1939a; Conard, 1938).

During the winter of 1936–37 Dr. Nichols and I compiled a preliminary list of the bryophytes of Michigan, which he prepared in mimeographed form in May, 1937, for use by his students at the University of Michigan Biological Station. This list contained the imposing total of 124 Hepaticae, 19 Sphagna, and 351 Musci. Unfortunately, Dr. Nichols' untimely death (Steere, 1939c) prevented the publication of our joint catalogue in the form which we had planned. Since further field work in all parts of the state has continued to add more species (Darlington, 1938; Schnooberger, 1940, 1943; Steere, 1940, 1942), its completion has been postponed until now.

The following list of Michigan bryophytes contains 132 species of Hepaticae, 21 species of Sphagna, and 361 species of Musci. The nomenclature and arrangement of the liverworts and of Sphagnum follow the check lists recently published by Evans and Andrews (*The Bryologist*, 43 : 132–138. 1940). The arrangement of the mosses and, to some extent, their nomenclature are taken from Brotherus' treatment in the second edition of Engler and Prantl's *Die natürlichen Pflanzenfamilien* (1924–25). The most appropriate name (in my opinion) is given for each species, and any other name under which it has been reported is added in parentheses. I shall be very grateful to users of this list who call to my attention any omissions from it, either of specimens or of literature which I have not seen.

CHECK LIST OF THE BRYOPHYTES OF MICHIGAN

Hepaticae

PTILIDIACEAE

Anthelia Juratzkana (Limpr.) Trevis.
Blepharostoma trichophyllum (L.) Dumort.
Ptilidium ciliare (L.) Nees
Ptilidium pulcherrimum (Web.) Hampe
Trichocolea tomentella (Ehrh.) Dumort.

LEPIDOZIACEAE

Bazzania trilobata (L.) S. F. Gray
Lepidozia reptans (L.) Dumort.
Microlepidozia setacea (Spruce) Joerg. (*Lepidozia setacea* Mitt.)

CALYPOGEIACEAE

Calypogeia fissa (L.) Raddi
Calypogeia Neesiana (Massal. & Carest.) K. Müll.
Calypogeia paludosa Warnst.
Calypogeia sphagnicola (Arn. & Pers.) Warnst. & Loeske
Calypogeia Trichomanis (L.) Corda (includes report of *C. suecica*)

CEPHALOZIACEAE

Cephalozia bicuspidata (L.) Dumort.
Cephalozia catenulata (Hüben.) Spruce
Cephalozia compacta Warnst.
Cephalozia connivens (Dicks.) Lindb.
Cephalozia lacinulata (Jack) Spruce

Cephalozia Loitlesbergeri Schiffn.
Cephalozia Macounii Austin
Cephalozia media Lindb. (*C. lunulaefolia* Dumort.)
Cephalozia pleniceps (Aust.) Lindb.
Cladopodiella fluitans (Nees) Buch (*Cephalozia fluitans* Spruce)
Nowellia curvifolia (Dicks.) Mitt. (*Cephalozia curvifolia* Dumort.)
Odontoschisma denudatum (Mart.) Dumort.
Odontoschisma Macounii (Aust.) Underwood

CEPHALOZIELLIACEAE

Cephaloziella byssacea (Roth) Warnst.
Cephaloziella elachista (Jack) Schiffn.
Cephaloziella Hampeana (Nees) Schiffn. (includes report of *C. divaricata*)
Cephaloziella rubella (Nees) Douin
Cephaloziella Sullivantii (Aust.) Evans

HARPANTHACEAE

Chiloscyphus fragilis (Roth) Schiffn.
Chiloscyphus pallescens (Ehrh.) Dumort.
Chiloscyphus rivularis (Schrad.) Loeske
Geocalyx graveolens (Schrad.) Nees
Harpanthus scutatus (Web. & Mohr) Spruce
Lophocolea heterophylla (Schrad.) Dumort.
Lophocolea minor Nees
Mylia anomala (Hook.) S. F. Gray

JUNGERMANNIACEAE

Anastrophyllum Michauxii (Web.) Buch (*Sphenolobus Michauxii* Steph.)
Barbilophozia barbata (Schmid.) Loeske (*Lophozia barbata* Dumort.)
Barbilophozia Hatcheri (Evans) Loeske (*Lophozia Hatcheri* Evans)
Barbilophozia lycopodioides (Wallr.) Loeske (*Lophozia lycopodioides* Cogn.)
Gymnocolea inflata (Huds.) Dumort. (*Lophozia inflata* M. A. Howe)
Isopaches bicrenatus (Schmid.) Buch (*Lophozia bicrenata* Dumort.)
Isopaches Hellerianus (Nees) Buch (*Sphenolobus Hellerianus* Steph.)
Jamesoniella autumnalis (DC.) Steph.
Jungermannia cordifolia Hook.
Jungermannia lanceolata L.
Jungermannia pumila With.
Jungermannia Schiffneri (Loitlesb.) Evans
Jungermannia sphaerocarpa Hook.
Leiocolea badensis (Gottsche) Joerg. (*Lophozia badensis* Schiffn.)
Leiocolea Gillmani (Aust.) Evans (*Jungermannia Gillmani* Aust.; *Lophozia Kaurini* (Limpr.) Steph.)
Leiocolea heterocolpa (Thed.) Buch (*Lophozia heterocolpa* M. A. Howe)
Leiocolea obtusa (Lindb.) Buch (*Lophozia obtusa* Evans)
Leiocolea Schultzii (Nees) Joerg.
Lophozia alpestris (Schleich.) Evans
Lophozia excisa (Dicks.) Dumort.
Lophozia incisa (Schrad.) Dumort.

Lophozia longidens (Lindb.) Macoun
Lophozia marchica (Nees) Steph.
Lophozia Mildeana (Gottsche) Schiffn.
Lophozia porphyroleuca (Nees) Schiffn.
Lophozia silvicola Buch
Lophozia ventricosa (Dicks.) Dumort.
Orthocaulis attenuatus (Mart.) Evans (*Lophozia attenuata* Dumort.)
Orthocaulis Kunzeanus (Hüben.) Buch (*Lophozia Kunzeana* Evans)
Plectocolea crenulata (Smith) Evans
Plectocolea crenuliformis (Aust.) Mitt. (*Nardia crenuliformis* Lindb.)
Plectocolea hyalina (Lyell) Mitt. (*Nardia hyalina* Carringt.)
Sphenolobus minutus (Crantz) Steph.
Tritomaria exsecta (Schmid.) Schiffn. (*Sphenolobus exsectus* Steph.)
Tritomaria exsectiformis (Breidl.) Schiffn. (*Sphenolobus exsectiformis* Steph.)
Tritomaria quinquedentata (Huds.) Buch (*Lophozia quinquedentata* Cogn.; *L. Lyoni* (Tayl.) Steph.)

MARSUPELLACEAE

Marsupella emarginata (Ehrh.) Dumort.
Marsupella sparsifolia (Lindb.) Dumort.
Marsupella sphacelata (Gies.) Dumort. (*M. Sullivantii* Evans)

PLAGIOCHILACEAE

Plagiochila asplenioides (L.) Dumort.

SCAPANIACEAE

Diplophyllum apiculatum (Evans) Steph.
Scapania apiculata Spruce
Scapania curta (Mart.) Dumort.
Scapania cuspiduligera (Nees) K. Müll.
Scapania gymnostomophila Kaal.
Scapania irrigua (Nees) Dumort.
Scapania mucronata Buch
Scapania nemorosa (L.) Dumort.
Scapania paludicola Loeske & K. Müll.
Scapania paludosa K. Müll.
Scapania subalpina (Nees) Dumort.
Scapania undulata (L.) Dumort. (includes *S. dentata* Dumort.)
Scapaniella glaucocephala (Tayl.) Evans (*Scapania glaucocephala* Aust.)

PORELLACEAE

Porella pinnata L.
Porella platyphylla (L.) Lindb.
Porella platyphylloidea (Schwein.) Lindb.

RADULACEAE

Radula complanata (L.) Dumort.
Radula obconica Sulliv.

FRULLANIACEAE

Frullania Asagrayana Mont.
Frullania Bolanderi Aust.
Frullania Brittoniae Evans
Frullania eboracensis Gottsche
Frullania inflata Gottsche
Frullania Oakesiana Aust.
Frullania Selwyniana Pears.

LEJEUNEACEAE

Cololejeunea Biddlecomiae (Aust.) Evans
Lejeunea cavifolia (Ehrh.) Lindb.

FOSSOMBRONIACEAE

Fossombronia cristula Aust.
Fossombronia foveolata Lindb.

PELLIACEAE

Pellia epiphylla (L.) Corda
Pellia Fabroniana Raddi
Pellia Neesiana (Gottsche) Limpr.

BLASIACEAE

Blasia pusilla L.

PALLAVICINIACEAE

Moerckia Flotowiana (Nees) Schiffn. (*Pallavicinia Flotowiana* Lindb.)
Pallavicinia Lyellii (Hook.) S. F. Gray

METZGERIACEAE

Metzgeria conjugata Lindb.
Metzgeria furcata (L.) Dumort.

RICCARDIACEAE

Riccardia latifrons Lindb.
Riccardia multifida (L.) S. F. Gray
Riccardia palmata (Hedw.) Caruth.
Riccardia pinguis (L.) S. F. Gray

MARCHANTIACEAE

Conocephalum conicum (L.) Dumort. (*Conocephalus conicus* Hill)
Lunularia cruciata (L.) Dumort.
Marchantia polymorpha L.
Preissia quadrata (Scop.) Nees (*P. commutata* Nees)

REBOULIACEAE

Asterella Ludwigii (Schwaegr.) Underwood
Mannia rupestris (Nees) Frye & Clark (*Grimaldia rupestris* Lindb.)
Reboulia hemisphaerica (L.) Raddi

RICCIACEAE

Riccia fluitans L.
Ricciocarpus natans (L.) Corda (*Riccia natans* L.)

ANTHOCEROTACEAE

Anthoceros laevis L.
Anthoceros Macounii M. A. Howe
Notothylas orbicularis (Schwein.) Sulliv.

Musci

SPHAGNACEAE

Sphagnum capillaceum (Weiss) Schrank (*S. acutifolium* Ehrh.)
Sphagnum compactum DC.
Sphagnum cuspidatum Ehrh.
Sphagnum Dusenii C. Jens.
Sphagnum fimbriatum Wils.
Sphagnum fuscum (Schimp.) H. Klinggr.
Sphagnum Girgensohnii Russow
Sphagnum magellanicum Brid.
Sphagnum palustre L.
Sphagnum papillosum Lindb.
Sphagnum plumulosum Röll
Sphagnum recurvum Beauv.
    var. tenue H. Klinggr.
Sphagnum robustum (Russow) Röll
Sphagnum rubellum Wils. (*S. capillaceum* var. *tenellum* (Schimp.) Andr.)
Sphagnum squarrosum Crome
Sphagnum subbicolor Hampe
Sphagnum subsecundum Nees (includes *S. platyphyllum* Sulliv.)
Sphagnum tenellum Pers.
Sphagnum teres (Schimp.) Aongstr.
Sphagnum Warnstorfii Russow
Sphagnum Wulfianum Girg.

ANDREAEACEAE

Andreaea Rothii Web. & Mohr
Andreaea rupestris Hedw. (*A. petrophila* Ehrh.)

GEORGIACEAE

Tetraphis pellucida Hedw. (*Georgia pellucida* Rabenh.)
Tetrodontium Brownianum (Dicks.) Schwaegr.

FISSIDENTACEAE

Fissidens adiantoides Hedw.
Fissidens bryoides Hedw.
Fissidens cristatus Wils. (*F. decipiens* De Not.)
Fissidens grandifrons Brid.
Fissidens incurvus Schwaegr.
Fissidens Julianus (Mont.) Schimp.
Fissidens obtusifolius Wils.
Fissidens osmundioides Hedw.
Fissidens subbasilaris Hedw.
Fissidens taxifolius Hedw.
Fissidens viridulus (Web. & Mohr) Wahlenb.

DITRICHACEAE

Ceratodon purpureus (Hedw.) Brid.
Distichium capillaceum (Hedw.) BSG. (*Swartzia montana* Lindb.)
Distichium inclinatum (Hedw.) BSG. (*Swartzia inclinata* Hedw.)
Ditrichum flexicaule (Schwaegr.) Hampe
Ditrichum giganteum Williams
Ditrichum lineare (Sw.) Lindb. (*D. vaginans* (Sulliv.) Hampe)
Ditrichum pallidum (Hedw.) Hampe
Ditrichum pusillum (Hedw.) E. G. Britt. (*D. tortile* (Schrad.) Brockm.)
Pleuridium subulatum (Hedw.) Lindb. (*P. alternifolium* Rabenh.)
Saelania glaucescens (Hedw.) Broth. (*S. caesia* Lindb.)

SELIGERIACEAE

Blindia acuta (Hedw.) BSG.
Seligeria campylopoda Kindb.
Seligeria Donniana (Smith) C. Müll.
Seligeria pusilla (Hedw.) BSG.
Seligeria recurvata (Hedw.) BSG.

DICRANACEAE

Anisothecium Grevilleanum (Brid.) Lindb. (*Dicranella Grevilleana* Schimp.)
Anisothecium Schreberianum (Hedw.) Dixon (*Dicranella Schreberi* Schimp.)
Anisothecium varium (Hedw.) Mitt. (*Dicranella rubra* (Huds.) Kindb.; *D. varia* Schimp.)
Bruchia Sullivantii Aust.
Cnestrum Schisti (Wahlenb.) Hagen
Cynodontium polycarpum (Hedw.) Schimp. (*Oncophorus polycarpus* Brid.)
Cynodontium strumiferum (Hedw.) De Not. (*Oncophorus strumiferus* Brid.)
Cynodontium tenellum (BSG.) Limpr. (*Oncophorus tenellus* Williams)
Dichodontium pellucidum (Hedw.) Schimp.
var. fagimontanum (Brid.) Schimp.
Dicranella heteromalla (Hedw.) Schimp.
Dicranella subulata (Hedw.) Schimp. (*D. secunda* (Sw.) Lindb.)
Dicranodontium denudatum (Brid.) Hagen

Dicranoweisia crispula (Hedw.) Lindb.
Dicranum Bergeri Bland. (*D. Schraderi* Web. & Mohr)
Dicranum Bonjeanii De Not. (*D. palustre* BSG.)
Dicranum condensatum Hedw. (*D. pallidum* BSG.)
Dicranum Drummondii C. Müll.
Dicranum fragilifolium Lindb.
Dicranum fulvum Hook.
Dicranum fuscescens Turn. (includes reports of *D. congestum* Brid.)
Dicranum Muehlenbeckii BSG.
Dicranum scoparium Hedw. (*D. scopariiforme* Kindb.)
Dicranum spurium Hedw.
Dicranum undulatum Turner (*D. rugosum* Brid.)
Dicranum viride (Sulliv. & Lesq.) Lindb.
Oncophorus virens (Hedw.) Brid.
Oncophorus Wahlenbergii Brid.
Orthodicranum flagellare (Hedw.) Loeske (*Dicranum flagellare* Hedw.)
Orthodicranum montanum (Hedw.) Loeske (*Dicranum montanum* Hedw.)
Paraleucobryum longifolium (Hedw.) Loeske (*Dicranum longifolium* Hedw.)
Rhabdoweisia denticulata (Brid.) BSG.
Trematodon ambiguus (Hedw.) Hornsch.

LEUCOBRYACEAE

Leucobryum glaucum (Hedw.) Schimp.

ENCALYPTACEAE

Encalypta ciliata Hedw.
Encalypta procera Bruch
Encalypta rhabdocarpa Schwaegr.
Encalypta streptocarpa Hedw. (*E. contorta* (Wulf.) Lindb.)

POTTIACEAE

Acaulon rufescens Jaeg.
Astomum Muhlenbergianum (Sw.) Grout (*A. Sullivantii* BSG.)
Barbula convoluta Hedw.
Barbula cylindrica (Tayl.) Schimp.
Barbula fallax Hedw.
Barbula michiganensis Steere
Barbula unguiculata Hedw.
Didymodon recurvirostris (Hedw.) Jennings (*D. rubellus* (Hoffm.) BSG.)
Didymodon rigidulus Hedw.
Didymodon tophaceus (Brid.) Jur.
Didymodon trifarius (Hedw.) Brid. (*D. luridus* Hornsch.)
Gymnostomum aeruginosum Smith (*G. rupestre* Schleich.)
Gymnostomum calcareum Nees & Hornsch.
Gyroweisia tenuis (Hedw.) Schimp.
Hymenostylium recurvirostrum (Hedw.) Dixon (*H. curvirostre* (Ehrh.) Lindb.)
Phascum cuspidatum Hedw. (*P. acaulon* L.)
Pottia truncata (Hedw.) Fürnr. (*P. truncatula* (L.) Lindb.)
Tortella fragilis (Drumm.) Limpr.

Tortella humilis (Hedw.) Jennings (*Barbula caespitosa* Schwaegr.; *Tortella caespitosa* Limpr.)
Tortella tortuosa (Turner) Limpr.
Tortula intermedia (Brid.) Berk.
Tortula mucronifolia Schwaegr. (includes reports of *T. subulata*)
Tortula obtusifolia Schwaegr.
Tortula papillosa (Wils.) Spruce
Tortula ruralis (Hedw.) Smith
Weisia viridula Hedw. (*W. controversa* Hedw.)

GRIMMIACEAE

Grimmia alpicola Hedw. var. rivularis (Brid.) Broth. (*Grimmia apocarpa* Hedw. var. *rivularis* Web. & Mohr)
Grimmia ambigua Sulliv.
Grimmia anomala Hampe (*G. Hartmani* Schimp. var. *anomala* Mönkem.)
Grimmia apocarpa Hedw.
Grimmia commutata Hüben.
Grimmia conferta Funck
Grimmia gracilis Schleich.
Grimmia Olneyi Sulliv.
Grimmia ovalis (Hedw.) Lindb. (*G. ovata* Schwaegr.)
Grimmia unicolor Hook.
Rhacomitrium aciculare (Hedw.) Brid.
Rhacomitrium canescens (Hedw.) Brid.
Rhacomitrium fasciculare (Hedw.) Brid.
Rhacomitrium heterostichum (Hedw.) Brid.
Rhacomitrium microcarpon (Hedw.) Brid. (*R. heterostichum* var. *ramulosum* (Lindb.) G. N. Jones)
Rhacomitrium patens (Hedw.) Hüben. (*Grimmia patens* BSG.)
Rhacomitrium sudeticum (Funck) BSG. (*R. heterostichum* var. *sudeticum* G. N. Jones)

EPHEMERACEAE

Ephemerum cohaerens (Hedw.) Hampe
Ephemerum spinulosum Schimp.

FUNARIACEAE

Aphanorrhegma serratum (Hook. & Wils.) Sulliv.
Funaria hygrometrica Hedw. (includes report of *F. flavicans*)
Physcomitrium turbinatum (Michx.) Brid.

SPLACHNACEAE

Splachnum ampullaceum Hedw.
Splachnum rubrum Hedw.
Tetraplodon angustatus (Hedw.) BSG.

SCHISTOSTEGACEAE

Schistostega pennata (Hedw.) Hook. & Tayl. (*S. osmundacea* Mohr)

BRYACEAE

Anomobryum filiforme (Dicks.) Husnot
Bryum argenteum Hedw.
var. lanatum BSG.
Bryum caespiticium Hedw.
Bryum capillare Hedw.
Bryum cernuum (Hedw.) BSG. (*B. uliginosum* (Bruch) BSG.)
Bryum cuspidatum (BSG.) Schimp. (*B. affine* Lindb.; *B. intermedium* Brid.)
Bryum inclinatum (Web. & Mohr) Sturm
Bryum Muehlenbeckii BSG.
Bryum pallens (P. Beauv.) Röhl. (*B. fallax* Milde)
Bryum pallescens Schleich.
Bryum pendulum (Hornsch.) Schimp.
Bryum pseudotriquetrum (Hedw.) Schwaegr. (*B. bimum* Turner; *B. ventricosum* Dicks.)
Bryum tortifolium Funck (*B. cyclophyllum* (Schwaegr.) BSG.)
Bryum Weigelii Spreng. (*B. Duvalii* Voit)
Leptobryum pyriforme (Hedw.) Schimp.
Mielichhoferia Mielichhoferiana (Funck) Limpr. (*M. nitida* Hornsch.)
Mniobryum albicans (Wahlenb.) Limpr. (*Pohlia Wahlenbergii* (Web. & Mohr) Andr.)
Pohlia acuminata Hoppe & Hornsch. (*Webera acuminata* Schimp.)
Pohlia cruda (Hedw.) Lindb. (*Webera cruda* Bruch)
Pohlia elongata Hedw.
Pohlia nutans (Hedw.) Lindb. (*Webera nutans* Hedw.)
Pohlia proligera Lindb.
Pohlia pulchella (Hedw.) Lindb.
Rhodobryum roseum (Hedw.) Limpr. (*R. ontariense* (Kindb.) Paris)

MNIACEAE

Cinclidium stygium Sw.
Mnium affine Bland. (*M. rugicum* Laur.)
Mnium ciliare (Grev.) Lindb. (*M. affine* var. *ciliare* C. Müll.)
Mnium cinclidioides Hüben.
Mnium cuspidatum Hedw.
Mnium Drummondii BSG.
Mnium lycopodioides (Hook.) Schwaegr. (*M. riparium* Mitt.)
Mnium medium BSG.
Mnium orthorrhynchum Brid.
Mnium punctatum Hedw.
var. elatum Schimp.
Mnium serratum Brid. (*M. marginatum* P. Beauv.)
Mnium spinulosum BSG.
Mnium stellare Hedw.
Mnium subglobosum BSG.

AULACOMNIACEAE

Aulacomnium androgynum (Hedw.) Schwaegr.
Aulacomnium heterostichum (Hedw.) BSG.
Aulacomnium palustre (Hedw.) Schwaegr.

MEESEACEAE

Amblyodon dealbatus (Hedw.) P. Beauv.
Meesea triquetra (Turn.) Aongstr. (*M. tristicha* BSG).
Meesea uliginosa Hedw. (*M. trichodes* Spruce)
Paludella squarrosa (Hedw.) Brid.

CATOSCOPIACEAE

Catoscopium nigritum (Hedw.) Brid.

BARTRAMIACEAE

Bartramia ithyphylla Brid.
Bartramia pomiformis Hedw.
Philonotis caespitosa Wils. var. compacta Dismier
Philonotis fontana (Hedw.) Brid.
Philonotis marchica (Hedw.) Brid.
Plagiopus Oederi (Brid.) Limpr.

TIMMIACEAE

Timmia austriaca Hedw.
Timmia megapolitana Hedw. (*T. cucullata* Michx.)

ORTHOTRICHACEAE

Amphidium lapponicum (Hedw.) Schimp.
Drummondia prorepens (Hedw.) Jennings (*D. clavellata* Hook.)
Orthotrichum affine Brid.
Orthotrichum anomalum Hedw.
Orthotrichum elegans Hook. & Grev. (includes reports of *O. speciosum*)
Orthotrichum Lescurii Aust.
Orthotrichum Macounii Aust.
Orthotrichum obtusifolium Brid.
Orthotrichum ohioense Sulliv. & Lesq.
Orthotrichum pumilum Dicks. (*O. fallax* Schimp.; *O. brachytrichum* Schimp.)
Orthotrichum sordidum Sulliv. & Lesq.
Orthotrichum stellatum Brid. (*O. Braunii* BSG.)
Orthotrichum strangulatum Schwaegr.
Ulota crispa (Hedw.) Brid. (*U. crispula* Bruch; *U. ulophylla* Broth.)
Ulota Hutchinsiae (Smith) Schimp. (*U. americana* (P. Beauv.) Limpr.)
Ulota Ludwigii (Brid.) Brid.

FONTINALACEAE

Dichelyma capillaceum (Brid.) BSG.
Dichelyma falcatum (Hedw.) Myrin
Dichelyma pallescens BSG.
Dichelyma uncinatum Mitt.
Fontinalis antipyretica Hedw.
    var. patula (Card.) Welch
Fontinalis biformis Sulliv.
Fontinalis disticha Hook. & Wils.

Fontinalis Duriaei Schimp.
Fontinalis gigantea Sulliv.
Fontinalis hypnoides Hartm.
Fontinalis Lescurii Sulliv.
Fontinalis missourica Card.
Fontinalis nitida Lindb. & Arnell
Fontinalis novae-angliae Sulliv.
var. Grouti Welch

CLIMACIACEAE

Climacium americanum Brid.
Climacium dendroides (Hedw.) Web. & Mohr
Climacium Kindbergii (Ren. & Card.) Grout

HEDWIGIACEAE

Hedwigia ciliata Hedw. (*H. albicans* Lindb.)

CRYPHAEACEAE

Forsstroemia trichomitria (Hedw.) Lindb.

LEUCODONTACEAE

Leucodon sciuroides (Hedw.) Schwaegr.

NECKERACEAE

Homalia Jamesii Schimp.
Neckera pennata Hedw.
var. oligocarpa (Bruch) Grout

THELIACEAE

Myurella Careyana Sulliv. (*M. gracilis* (Weinm.) Lindb.)
Myurella julacea (Schwaegr.) BSG.
Thelia asprella Sulliv.

FABRONIACEAE

Anacamptodon splachnoides (Fröhl.) Brid.

LESKEACEAE

Leskea arenicola Best
Leskea gracilescens Hedw.
Leskea obscura Hedw.
Leskea polycarpa Hedw.
Leskeella nervosa (Schwaegr.) Loeske (*Leskea nervosa* Myrin)
Leskeella tectorum (A. Braun) Hagen
Lindbergia Austinii (Sulliv.) Broth. (*L. brachyptera* (Mitt.) Kindb. var. *Austinii* Grout)
Pseudoleskea atrovirens (Dicks.) Best
Pseudoleskea oligoclada Kindb.
Pseudoleskea radicosa (Mitt.) Lesq. & James
Pterigynandrum filiforme Hedw.

THUIDIACEAE

Abietinella abietina (Brid.) BSG. (*Thuidium abietinum* BSG.)
Anomodon attenuatus (Hedw.) Hüben.
Anomodon minor (P. Beauv.) Lindb.
Anomodon rostratus (Hedw.) Schimp.
Anomodon Rugelii (C. Müll.) Keissl. (*A. apiculatus* BSG.)
Anomodon viticulosus (Hedw.) Hook. & Tayl.
Haplocladium microphyllum (Hedw.) Broth. (*Thuidium microphyllum* Best)
Haplocladium virginianum (Brid.) Lindb. (*Thuidium virginianum* Lindb.)
Haplohymenium triste (Cesati) Kindb. (*Anomodon tristis* Sulliv.)
Helodium Blandowii (Web. & Mohr) Warnst. (*H. lanatum* Broth.)
Helodium paludosum (Sulliv.) Aust. (*Thuidium elodioides* Ren. & Card.)
Heterocladium squarrosulum (Voit) Lindb.
Rauia scita (P. Beauv.) Aust. (*Thuidium scitum* Aust.)
Thuidium delicatulum (Hedw.) Mitt.
Thuidium minutulum (Hedw.) BSG.
Thuidium Philiberti Limpr.
Thuidium recognitum (Hedw.) Lindb.

AMBLYSTEGIACEAE

Amblystegiella confervoides (Brid.) Loeske
Amblystegiella subtilis (Hedw.) Loeske
Amblystegium compactum (C. Müll.) Aust.
Amblystegium Juratzkanum Schimp.
Amblystegium serpens (Hedw.) BSG.
Amblystegium varium (Hedw.) Lindb. (includes report of *A. radicale*)
Calliergon cordifolium (Hedw.) Kindb. (*Hypnum cordifolium* Hedw.)
Calliergon giganteum (Schimp.) Kindb.
Calliergon Richardsonii (Mitt.) Kindb.
Calliergon stramineum (Brid.) Kindb. (*Hypnum stramineum* Brid.)
Calliergon trifarium (Web. & Mohr) Kindb. (*Drepanocladus trifarius* Broth.)
Calliergonella cuspidata (Hedw.) Loeske (*Hypnum cuspidatum* Hedw.; *Acrocladium cuspidatum* Lindb.; *Calliergon cuspidatum* Kindb.)
Campylium chrysophyllum (Brid.) Bryhn (*Hypnum chrysophyllum* Brid.; *Chrysohypnum chrysophyllum* Loeske; *Hypnum sinuolatum* Kindb.)
Campylium hispidulum (Brid.) Mitt. (*Hypnum hispidulum* Brid.; *Chrysohypnum hispidulum* Roth)
var. Sommerfeltii (Myrin) Lindb. (*Chrysohypnum Sommerfeltii* Roth)
Campylium polygamum (BSG.) Bryhn (*Chrysohypnum polygamum* Loeske)
Campylium stellatum (Hedw.) Lange & C. Jens. (*Hypnum stellatum* Hedw.; *Chrysohypnum stellatum* Loeske)
Cratoneuron commutatum (Hedw.) Roth
Cratoneuron filicinum (Hedw.) Roth (*Hygroamblystegium filicinum* Loeske)
Drepanocladus aduncus (Hedw.) Warnst. (*Hypnum aduncum* Hedw.; *D. Sendtneri* (Schimp.) Warnst.)
var. Kneiffii (BSG.) Warnst. (*D. Kneiffii* Warnst.)
var. capillifolius (Warnst.) Wynne
Drepanocladus exannulatus (Gümb.) Warnst.
var. Rotae (De Not.) Grout
Drepanocladus fluitans (Hedw.) Warnst. (*Hypnum fluitans* Hedw.)

Drepanocladus revolvens (Turn.) Warnst. (*D. intermedius* Warnst.)
Drepanocladus uncinatus (Hedw.) Warnst. (*Hypnum uncinatum* Hedw.)
Drepanocladus vernicosus (Lindb.) Warnst. (*Hypnum vernicosum* Lindb.)
Hygroamblystegium fluviatile (Hedw.) Loeske (*Amblystegium fluviatile* BSG.)
Hygroamblystegium irriguum (Wils.) Loeske (*Amblystegium irriguum* BSG.) var. spinifolium (Schimp.) Grout
Hygroamblystegium noterophilum (Sulliv.) Warnst. (*Amblystegium noterophilum* Holz.)
Hygroamblystegium orthocladum (P. Beauv.) Grout (*Amblystegium orthocladum* Card.)
Hygrohypnum dilatatum (Wils.) Loeske
Hygrohypnum eugyrium (BSG.) Loeske
Hygrohypnum luridum (Hedw.) Dixon (*H. palustre* (Huds.) Loeske) var. subsphaericarpum (Schleich.) (includes report of *H. polare.*)
Hygrohypnum molle (Schimp.) Loeske
Hygrohypnum ochraceum (Turn.) Loeske
Leptodictyum Kochii (BSG.) Warnst. (*Amblystegium Kochii* BSG.)
Leptodictyum riparium (Hedw.) Warnst. (*Amblystegium riparium* BSG.)
Leptodictyum trichopodium (Schultz) Warnst.
Pleurozium Schreberi (Brid.) Mitt. (*Hypnum Schreberi* Brid.; *Calliergon Schreberi* Grout; *Calliergonella Schreberi* Grout)
Scorpidium scorpioides (Hedw.) BSG. (*Hypnum scorpidioides* Hedw.; *Drepanocladus scorpidioides* Warnst.)

BRACHYTHECIACEAE

Brachythecium acutum (Mitt.) Sulliv.
Brachythecium Bestii Grout
Brachythecium campestre BSG.
Brachythecium digastrum C. Müll. & Kindb.
Brachythecium flexicaule Ren. & Card.
Brachythecium oxycladon (Brid.) Jaeg. & Sauerb. (*B. laetum* (Brid.) BSG.) var. dentatum (Lesq. & James) Grout
Brachythecium plumosum (Hedw.) BSG.
Brachythecium populeum (Hedw.) BSG.
Brachythecium reflexum (Starke) BSG.
Brachythecium rivulare BSG.
Brachythecium rutabulum (Hedw.) BSG.
Brachythecium salebrosum (Web. & Mohr) BSG.
Brachythecium Starkei (Brid.) BSG.
Brachythecium velutinum (Hedw.) BSG.
Bryhnia graminicolor (Brid.) Grout
Bryhnia novae-angliae (Sulliv. & Lesq.) Grout
Chamberlainia acuminata (Hedw.) Grout (*Brachythecium acuminatum* Kindb.)
Chamberlainia cyrtophylla (Kindb.) Grout (*Brachythecium cyrtophyllum* Kindb.)
Cirriphyllum piliferum (Hedw.) Grout
Eurhynchium diversifolium (Schleich.) BSG.
Eurhynchium hians (Hedw.) Jaeg. & Sauerb.
Eurhynchium pulchellum (Hedw.) Dixon (*E. strigosum* (Hoffm.) BSG.) var. praecox (Hedw.) Dixon (*E. strigosum* var. *praecox* Limpr.)
Platyhypnidium riparioides (Hedw.) Dixon (*Eurhynchium rusciforme* Milde;

Oxyrrhynchium rusciforme Warnst; *P. rusciforme* Fleisch; *Hygrohypnum Nicholsii* Grout)
Rhynchostegium serrulatum (Hedw.) Jaeg. & Sauerb. (*Eurhynchium serrulatum* Kindb.)
Tomenthypnum nitens (Hedw.) Loeske (*Camptothecium nitens* Schimp.)

ENTODONTACEAE

Entodon cladorrhizans (Hedw.) C. Müll. (*Cylindrothecium cladorrhizans* Schimp.)
Entodon seductrix (Hedw.) C. Müll. (*Cylindrothecium seductrix* Sulliv.)

PLAGIOTHECIACEAE

Isopterygium deplanatum (Sulliv.) Grout (*Plagiothecium deplanatum* Grout; *Taxiphyllum deplanatum* Fleisch.; *Rhynchostegium deplanatum* Schimp.)
Isopterygium elegans (Hook.) Lindb. (*Plagiothecium elegans* Sulliv.)
Isopterygium Muellerianum (Schimp.) Lindb. (*Plagiothecium Muellerianum* Schimp.)
Isopterygium pulchellum (Hedw.) Jaeg.
Isopterygium turfaceum (Lindb.)Lindb. (*Plagiothecium turfaceum* Lindb.)
Plagiothecium denticulatum (Hedw.) BSG.
Plagiothecium laetum BSG.
Plagiothecium Roeseanum (Hampe) BSG. (*P. Roesei* Hampe)
Plagiothecium Ruthei Limpr.
Plagiothecium striatellum (Brid.) Lindb.
Plagiothecium sylvaticum (Brid.) BSG.

SEMATOPHYLLACEAE

Brotherella delicatula (James) Fleisch. (*Rhaphidostegium laxepatulum* Lesq. & James)
Brotherella recurvans (Michx.) Fleisch. (*Stereodon recurvans* Broth.)
Brotherella tenuirostris (Schimp.) Broth.
Heterophyllium Haldanianum (Grev.) Kindb. (*Hypnum Haldanianum* Grev.)

HYPNACEAE

Breidleria arcuata (Lindb.) Loeske (*Hypnum arcuatum* Lindb.; *Hypnum patientiae* Lindb.; *Stereodon Lindbergii* Warnst.)
Breidleria pratensis (Koch) Loeske (*Hypnum pratense* Koch; *Stereodon pratensis* E. G. Britt.)
Ctenidium molluscum (Hedw.) Mitt. (*Hypnum molluscum* Hedw.)
Homomallium adnatum (Hedw.) Broth.
Hypnum cupressiforme Hedw. (*Stereodon cupressiformis* Lindb.)
Hypnum curvifolium Hedw.
Hypnum fertile Sendt.
Hypnum imponens Hedw. (*Stereodon imponens* Lindb.)
Hypnum pallescens (Hedw.) BSG. (*Stereodon pallescens* Lindb.)
Hypnum reptile Michx. (*Stereodon reptilis* Mitt.)
Platygyrium repens (Brid.) BSG.
Ptilium crista-castrensis (Hedw.) De Not. (*Hypnum crista-castrensis* Hedw.)
Pylaisia intricata (Hedw.) BSG.
Pylaisia polyantha (Hedw.) BSG.

Pylaisia Selwynii Kindb. (*P. Schimperi* Card.)
Pylaisia subdenticulata Schimp.

RHYTIDIACEAE

Rhytidiadelphus squarrosus (Hedw.) Warnst.
Rhytidiadelphus triquetrus (Hedw.) Warnst. (*Hylocomium triquetrum* Hedw.)
Rhytidium rugosum (Hedw.) Kindb.

HYLOCOMIACEAE

Hylocomiastrum pyrenaicum (Spruce) Fleisch. (*Hylocomium pyrenaicum* Lindb.)
Hylocomium splendens (Hedw.) BSG. (*H. proliferum* (L.) Lindb.)
Hylocomium umbratum (Hedw.) BSG.

BUXBAUMIACEAE

Buxbaumia aphylla Hedw.
Buxbaumia subcylindrica Grout (includes report of *B. indusiata*)

DIPHYSCIACEAE

Diphyscium foliosum (Hedw.) Mohr (*D. sessile* (Schmid.) Lindb.; *Webera sessilis* Lindb.)

POLYTRICHACEAE

Atrichum angustatum (Brid.) BSG. (*Catharinaea angustata* Brid.)
Atrichum crispum (James) Sulliv.
Atrichum Macmillani (Holz.) Frye
Atrichum undulatum (Hedw.) P. Beauv. (*Catharinaea undulata* Web. & Mohr)
Pogonatum capillare (Michx.) Brid.
Pogonatum alpinum (Hedw.) Röhl. (*Polytrichum alpinum* Hedw.)
Polytrichum commune Hedw.
Polytrichum formosum Hedw.
Polytrichum gracile Smith
Polytrichum juniperinum Hedw.
Polytrichum ohioense Ren. & Card. (*P. decipiens* Limpr.)
Polytrichum piliferum Hedw.
Polytrichum strictum Smith

University of Michigan

LITERATURE CITED

This list is intended to include all publications which deal specifically with Michigan bryophytes, as well as papers which cite original Michigan records for various species. It also includes a few publications not mentioned in the text.

Andrews, A. L. 1913. Sphagnaceae. North American Flora, 15 : 1–31.

Austin, C. F. 1872. New Hepaticae. Bull. Torrey Bot. Club, 3 : 9–18.

Britton, Elizabeth G. 1913a. Ditrichaceae. North American Flora, 15 : 55–67.

—— 1913b. Seligeriaceae. *Ibid.*, 15 : 71–75.

Conard, H. S. 1938. The Foray in Upper Michigan, 1937. Bryologist, 41 : 18–22.

Conklin, G. H. 1914. A List of Hepaticae Collected upon Isle Royale, Lake Superior. Bryologist, 17 : 46–48, 52–55.

Cooper, W. S. 1912. The Ecological Succession of Mosses, as Illustrated upon Isle Royale, Lake Superior. Plant World, 15 : 197–213.

—— 1913. A List of Mosses Collected upon Isle Royale, Lake Superior. Bryologist, 16 : 3–8.

—— 1928. Seventeen Years of Successional Change upon Isle Royale, Lake Superior. Ecology, 9 : 1–5, 2 pls., 1 fig.

Daniels, F. P. 1904a. The Flora of the Vicinity of Manistee, Mich. Ann. Rep. Mich. Acad. Sci., 4 (1902) : 125–144.

—— 1904b. Ecology of the Flora of Sturgis, Mich., and Vicinity. *Ibid.*, 4 (1902) : 145–159.

Darlington, H. S. 1938. Bryophytes Collected in the Vicinity of Glen Lake, Leelanau County, Michigan. Bryologist, 41 : 99–106.

Evans, A. W., and Nichols, G. E. 1935. The Liverwort Flora of the Upper Michigan Peninsula. Bryologist, 38 : 81–91.

Gates, Frank C. 1912. The Vegetation of the Region in the Vicinity of Douglas Lake, Cheboygan County, Michigan, 1911. Ann. Rep. Mich. Acad. Sci., 14 : 46–106.

Gillman, H. 1876. Distribution of *Preissia commutata*, Nees. Bull. Torrey Bot. Club, 6 : 94.

Grout, A. J. 1935. *Hygrohypnum Nicholsii* n. sp. Bryologist, 38 : 10, 1 fig.

—— and Others. 1928–1940. Moss Flora of North America, North of Mexico, 3 vols. Newfane, Vermont.

Hill, E. J. 1885. The Menominee Iron Region and Its Flora. Bot. Gaz., 10 : 208–211, 225–229.

—— 1886. A Botanical Diary. *Ibid.*, 11 : 183–184.

—— 1900. Flora of the White Lake Region, Michigan, and Its Ecological Relations. *Ibid.*, 29 : 419–436.

—— 1902. *Fissidens grandifrons*, Its Habits and Propagation. Bryologist, 5 : 56–58.

—— 1905. *Encalypta procera* Bruch. *Ibid.*, 8 : 107–110.

—— 1909. Note on *Amblystegium noterophilum*. *Ibid.*, 12 : 108–109.

Holt, W. P. 1909. Notes on the Vegetation of Isle Royale, Michigan. *In* "An Ecological Survey of Isle Royale, Lake Superior, Prepared under the Direction of Chas. C. Adams," pp. 217–248, Rep. Mich. Geol. Surv., 1908. Lansing.

Kauffman, C. H. 1915. A Preliminary List of the Bryophytes of Michigan. Ann. Rep. Mich. Acad. Sci., 17 : 217–223.

Meylan, C. 1938. Le *Pseudoleskea illyrica* de Glowacki et les espèces affines. Ann. Bryol., 11 : 90–93.

Nichols, G. E. 1922. The Bryophytes of Michigan, with Particular Reference to the Douglas Lake Region. Bryologist, 25 : 41–58.

—— 1925. (Same title, II). *Ibid.*, 28 : 73–75.

—— 1932. Notes on Michigan Bryophytes. *Ibid.*, 35 : 5–9.

—— 1933. (Same title, II). *Ibid.*, 36 : 69–78.

—— 1935. The Bryophytes of Michigan with Special Reference to the Huron Mountain Region. *Ibid.*, 38 : 11–19.

—— 1937. The Bryophytes of Michigan: a Preliminary List. 18 pages, mimeographed. New Haven, Connecticut.

—— 1938. Bryophytes of the Huron Mountain Region, Marquette County, Michigan. Bryologist, 41 : 25–31.

—— and Steere, W. C. 1936. Notes on Michigan Bryophytes. — III. *Ibid.*, 39 : 111–118.

—— —— 1937. Bryophytes of the Porcupine Mountains, Ontonagon County, Michigan. Pap. Mich. Acad. Sci., Arts, and Letters, 22 (1936) : 183–200.

Praeger, W. E. 1919. A Collection of Sphagnum from the Douglas Lake Region, Cheboygan County, Michigan. Ann. Rep. Mich. Acad. Sci., 21 : 337–338.

Povah, A. H. 1929. Some Non-Vascular Cryptogams from Vermilion, Chippewa County, Michigan. Pap. Mich. Acad. Sci., Arts, and Letters, 9 (1928) : 253–272.

Robinove, J. J., and La Rue, C. D. 1929. The Hydrogen-Ion Concentration of the Habitats of the Bryophytes and Pteridophytes of the Douglas Lake Region. *Ibid.*, 9 (1928) : 273–286.

Röll, J. 1897. Beiträge zur Moosflora von Nord-Amerika. Hedwigia, 36 : 41–66.

Schnooberger, Irma. 1940. Notes on Bryophytes of Central Michigan. Pap. Mich. Acad. Sci., Arts, and Letters, 25 (1939) : 101–106.

—— 1943. The 1942 Foray. Bryologist, 46 : 146–148.

[Smith, Annie M.] 1900. A periodic report for the Sullivant Moss Chapter containing a record of the finding of two species by Charles K. Dodge. Bryologist, 3 (3) : 16.

Sprague, C. J. 1858. A Small Collection of Cryptogamous Plants Brought by Dr. Samuel Kneeland, Jr., from the Lake Superior Region. Proc. Boston Soc. Nat. History, 6 : 296.

Stearns, Frances L. 1905. A Study of Plants in Ravines near Adrian [Michigan]. Ann. Rep. Mich. Acad. Sci., 7 : 68–72.

Steere, W. C. 1931a. Notes on the Mosses of Southern Michigan. Bryologist, 34 : 1–5.

—— 1931b. *Meesea triquetra*. Rhodora, 33 : 77–78, 1 pl.

—— 1933a. Notes on the Mosses of Southern Michigan. II. Bryologist, 36 : 24.

—— 1933b. The Association of *Bartramia pomiformis* and *Aulacomnium heterostichum*. *Ibid.*, 36 : 14–15.

—— 1934a. Unreported or Otherwise Interesting Bryophytes from Michigan. *Ibid.*, 37 : 57–62.

—— 1934b. The Bryophytes of the Chase S. Osborn Preserve of the University of Michigan, Sugar Island, Chippewa County, Michigan. Am. Mid. Nat., 15 : 761–769.

—— 1934c. Unreported or Otherwise Interesting Bryophytes from Michigan. II. Bryologist, 37 : 79–82.

—— 1937. Critical Bryophytes from the Keweenaw Peninsula, Michigan. Rhodora, 39 : 1–14, 33–46, 6 figs.

—— 1938. (Same title, II.) Ann. Bryol., 11 : 145–152, 2 figs.

—— 1939a. *Gyroweisia tenuis* in North America. Bryologist, 42 : 16–23.

—— 1939b. Barbula in North America North of Mexico. Bull. Torrey Bot. Club, 66 : 93–119.

—— 1939c. George Elwood Nichols, 1882–1939 [with portrait]. Bryologist, 42 : 137–142.

—— 1940. Liverworts of Southern Michigan. Cranbrook Inst. Sci., Bull. 17 : 1–97. Frontispiece + 22 pls. Bloomfield Hills, Michigan.

—— 1942. Notes on Michigan Bryophytes, — IV. Bryologist, 45 : 153–172.

Thorpe, Frances, and Povah, A. H. 1935. The Bryophytes of Isle Royale, Lake Superior. *Ibid.*, 38 : 32–46.

Wynne, Frances E. 1945. Studies in *Drepanocladus*. IV. Taxonomy. Bryologist, 47 (1944) : 147–189, 10 pls., 5 maps.

ALGAE COLLECTED BY THE "HASSLER," "ALBATROSS," AND SCHMITT EXPEDITIONS

III. MARINE ALGAE FROM PERU AND CHILE

WM. RANDOLPH TAYLOR

INTRODUCTION

IN TWO other contributions (Taylor, 1930, p. 627; 1939, p. 127) the writer has dealt with algae from the chief expeditions with whose collections this paper is concerned. Since in the introductions to them descriptions of the expeditions and citations of sources of information respecting them have been given, little more need be written here. In brief, the U.S.C.S. Steamer "Hassler," when she sailed to her West Coast station, carried a scientific staff under the direction of Louis Agassiz. She left Boston in December, 1871, and reached San Francisco in August, 1872; the part of the trip covered by this present paper, comprising the northern Chilean and Peruvian collections, was all in the year 1872. Not included here are the bulk of the algae from the Juan Fernandez Islands, which have been sent to Dr. Tore Levring of Lund, Sweden, to use in conjunction with other material in a paper (Levring, 1941) on the algae of that island group. The algae of Ecuador, principally those of the Galapagos Islands, from all three sources contributing to this series of papers, have been incorporated in a report now recently issued (1945). There is little of "Albatross" [1] material concerned in the present paper; that which the expedition secured in the Galapagos and Revillagigedo islands has also been included in the paper just mentioned. Of "Hassler" [1]

[1] The material from the "Hassler," "Albatross," and Schmitt expeditions reached the writer either in fluid or unsorted on paper, without being provided with individual numbers. The present author, when mounting and arranging these collections, assigned serial numbers in each case, in order to provide for the identification of the duplicate material. These numbers should not be interpreted as indicating any original sequence of collection in the field or in the herbarium.

material there remains a little from Baja California and southern California, but probably not enough to justify separate publication. There is also a suite of specimens to the present not associated with any reliable data; should their geographic source be ascertained later, they will be worth reporting upon.

It is still too early to draw any very detailed conclusions on floristic matters for this area. As the writer has recently determined, the flora of the Galápagos Islands, though hardly completely tropical, especially in the southern islands, in no great measure resembles that of Peru. The flora of mainland Ecuador is less known than that of Peru, and the transition region, though probably in southern Ecuador, has not been distinguished for lack of adequately extensive records. We have a fairly good idea of the flora of the Strait of Magellan; the floras of central and northern Chile clearly involve a considerable change, for some of the characteristic large things from farther south do not occur there. However, we as yet know little of the marine flora of Chile above the Strait (Montagne, 1852). The flora of the Juan Fernandez Islands is the best known of this region from Levring's reports (1941, 1942). Previously the only special algal paper on the islands was the small one by Montagne (1835). On the mainland so far north a number of warm-water species begin to appear in the flora, large codiums and Padina, for example. The flora of Easter Island (Rapa Nui) reported by Børgesen has a Caribbean aspect with in general the same genera and similar, though not identical, species. Easter Island is nearly in the latitude of Caldera, but far west of the Humboldt Current, which lowers the temperature of the water along the mainland as far north as the Galápagos Islands and perhaps in somewhat lesser proportion that about the Juan Fernandez Islands. These islands are a good deal farther south than Easter Island, about seven degrees of latitude, but seem to have some warm-water species not yet recorded from the opposite mainland.

The "Hassler" and "Albatross" material was made available by the kindness of Dr. C. W. Dodge and, later, Dr. D. H. Linder, curators of the Farlow Herbarium, Harvard University. The algae collected by Dr. Waldo L. Schmitt [2] while on a Walter Rathbone Bacon Scholarship during 1925–27 are an important element in the present paper, and with them are materials which he collected in 1935 while

[2] See footnote 1.

on the Allan Hancock Expedition of the University of Southern California of that year. A small addition came from specimens received from the Chicago Natural History Museum kindly sent by the curator of cryptogams, Dr. Francis Drouet, collected by Sr. Angel Maldonado in 1942, and one important sample of rough-dried material collected by Professor H. H. Bartlett of the University of Michigan, from Antofagasta, Chile. To all these contributors of algae the writer desires to express his gratitude. As detailed before (1939, p. 129), various institutions have granted special facilities for comparison of this material with their own collections; one must add to those already mentioned the names of Dr. Fred J. Seaver, New York Botanical Garden; Dr. F. W. Pennell, Philadelphia Academy of Natural Sciences; and Dr. H. L. Mason, University of California. The late Dr. M. A. Howe, of New York, and Drs. W. A. Setchell and N. L. Gardner, of Berkeley (who often reported jointly), made determinations of several specimens in which they were interested. Dr. G. J. Hollenberg kindly determined specimens of Polysiphonia, and Dr. G. F. Papenfuss helped to locate useful specimens at Berkeley. Professor H. H. Bartlett kindly prepared the Latin diagnoses of new species.

List of Species

CHLOROPHYCEAE

ULVACEAE

Enteromorpha bulbosa (Suhr) Mont. — Plants gregarious, 3–10 cm. tall, very slender and sparingly branched from near the base, the mature branches to 3 mm. diam., straight or somewhat compressed and contorted; cells to 15–22 μ diam., somewhat regularly arranged but not in long, evident rows, of irregular shape and with rounded angles, the lateral cell walls rather thin, the inner and outer walls distinctly thicker.

Peru: Herradura, from fresh water, *Schmitt 181*, Oct. 31, 1926. Paita, rocks south of the railroad station, *Schmitt 546*, Oct. 6, 1926. Chile: Caldera, *Hassler 1128* (?), 1872.

References: Suhr, 1839, p. 72, pl. 4, fig. 46, as *Solenia bulbosa*. Montagne, 1846, p. 3. Howe, 1914, p. 22.

The description based on the Peruvian specimens shows forms which in general size and cell size do not reach the extremes cited by Howe (1914, p. 23). The Chilean material is larger and lighter in color, with somewhat thicker cell walls.

ENTEROMORPHA COMPRESSA (L.) Grev. — Peru: Paita, *Hassler 97*, 1872.

References: Montagne, 1846, p. 3. Taylor, 1937, p. 64.

Montagne (*loc. cit.*) records this species from Paita; though it is probably absent from the intermediate tropical seas, it seems to be present on the north and south American Pacific shores.

ENTEROMORPHA INTESTINALIS (L.) Grev. — Peru: Herradura, *Schmitt 176*, Oct. 31, 1926.

References: Montagne, 1839, pp. 3, 5. Taylor, 1937, p. 65, pl. 3, fig. 7.

ENTEROMORPHA LINGULATA J. Ag. — Peru: Paita, *Hassler 95*, 1872. Chile: Arica, *Hassler 14*, 1872.

Reference: Taylor, 1942, p. 13.

These very slender plants agree in most respects with the description given earlier by the writer (*loc. cit.*), but the cells are rather smaller, generally 7–9 μ diam.

ENTEROMORPHA LINZA (L.) J. Ag. — Chile: Arica, *Hassler 10*, *11*, *12*, 1872.

Reference: Taylor, 1937, p. 68, pl. 3, fig. 8.

Since the bases of these plants are missing or obscured and the blades untidily mounted, the writer found them not fully satisfactory for study. The blade thickness was about 30 μ, which so far confirmed the determination.

ULVA FASCIATA Delile f. COSTATA Howe. — Peru: Punta Talara, *Schmitt 166*, Aug. 29, 1926. Paita, *Hassler 90*, 1872; *ibid.*, rocks north of the railroad station, *Schmitt 545* (?), Oct. 6, 1926. Islas Lobos de Afuera, shore rocks, *Schmitt 391F–35*, Jan. 17, 1936. Callao, *Maldonado 300*, June, 1942; *ibid.*, on Isla San Lorenzo, *Schmitt 197*, Nov. 3, 1926. Salaverry, on wreckage, *Schmitt 574*, Oct. 21, 1926.

Reference: Howe, 1914, p. 20.

ULVA LACTUCA L. var. LATISSIMA (L.) De Cand. — Chile: Arica, *Hassler 9*, *13*, 1872.

Reference: Taylor, 1937, p. 75.

ULVA LACTUCA L. var. RIGIDA (C. Ag.) Le Jol. — Peru: Paita,

Hassler 85, 106. Callao, at Isla San Lorenzo, *Schmitt 189* (?), Nov. 1, 1926; *ibid.*, dredged, *Schmitt 204* (?), Nov. 7, 1926.

Reference: Taylor, 1937, p. 75.

VALONIACEAE

MICRODICTYON JAPONICUM Setchell. — Chile: Islas Juan Fernandez, dredged in 27–37 meters in Bahía Carbajal, *Schmitt 149*, Dec. 15, 1926, det. Setchell; *ibid.*, at Isla Santa Clara, *Schmitt 133*, Dec. 11, 1926.

Reference: Setchell, 1929, p. 528, figs. 49–56.

CLADOPHORACEAE

CHAETOMORPHA ANTENNINA (Bory) Kütz. f. — Chile: Caldera, *Hassler 1126*, 1872.

Reference: Taylor, 1945, p. 52.

Chaetomorpha peruviana, sp. nov. — Plants tufted, 5–7 cm. tall, the filaments dark green and stiff; cell walls of moderate thickness; basal cell to 720–850 μ long, at the bottom discoid-expanded and lobed, at the top about one fifth as broad as long; filaments 125–240 μ diam., the cells subequal to twice as long as broad, slightly swollen; in the upper portion the fertile cells considerably swollen, to 320 μ diam.

Peru: Paita, *Hassler 96*, 1872 (TYPE). Chile: Lota, *Hassler 1138*, 1872.

Plantae caespitosae, 5–7 cm. altae, filamentis atriviridibus, rigidis, 125–240 μ diam., membrana cellularum modice crassa; cellulis subaequalibus vel bis longioribus quam latioribus, paulum tumidis, in parte filamenti superiore cellulis fertilibus distincte tumidis, grandioribus 320 μ diam.; cellula basali longitudine 720–850 μ attingente, basi discoidali expansa et lobata, prope apicem circa quinquies longiore quam crassiore.

Peru, in loco dicto Paita; legit "Hassler Expedition," *96*, 1872.

Howe (1914, p. 36) describes *C. cartilaginea* as coarser than *C. aerea* (Dillw.) Kütz.; here we have a plant somewhat softer than *C. aerea* usually is, but with overlapping characters and very hard to define as distinct from that species. What appears to be a variant from Herradura is much taller and softer, but in warm

tide pools a parallel variant of the New England *C. aerea* is occasionally found. On the whole, it is probable that these South American plants are specifically distinct, about one third more slender, softer and perhaps of darker color than their northern counterparts.

CHAETOMORPHA PERUVIANA var. **elongata,** var. nov. — Plants (detached) probably more than 15 cm. tall, dark green, flexuose but not notably entangled, the base (of young epiphytic filaments) with a small simple irregularly discoid holdfast, the basal cell above this somewhat club-shaped, below 45–58 μ diam., above 70–115 μ diam. and 700–930 μ long (but no doubt larger in mature filaments); cell next above the basal cell little broader, to 2–3 diameters long; cells of most of the mature filaments 0.75–2.0 diameters long and little contracted at the nodes; upper cells of older filaments 190–225 μ diam., 225–385 μ long, markedly cask-shaped; uppermost and apparently sporangial cells when empty subspherically much distended to 360 μ diam., those below likewise but somewhat less strongly distended, to 255–290 μ diam., 255–385 μ long.

Peru: Herradura, *Schmitt 178*, Oct. 31, 1926 (TYPE).

Plantae plus quam 15 cm. altae, juventate parte superiore cellulae basalis claviformi, 8-plo longiore quam latiore, parte inferiore irregulari disciformi; filamento sursum ex cellulis tumidis 190–225 μ diam., 225–385 μ longis constanti; cellulis sporangialibus minus quam 360 μ diametientibus, subglobosis.

Peru, in loco dicto Herradura; legit Schmitt, *178*, 1926.

CHAETOMORPHA CARTILAGINEA Howe. — Peru: Callao, dredged from 5.4 meters' depth parallel to Isla San Lorenzo, *Schmitt 364B–35*, Jan. 10, 1935.

Reference: Howe, 1914, p. 36, pl. 3, figs. 11–13; pl. 5.

These specimens seem identical in character with those described by Howe (*loc. cit.*) from the region of Callao, differing in the same way from the type and likewise lacking elongate basal cells.

RHIZOCLONIUM TORTUOSUM (Dillw.) Kütz. — Filaments entangled, dull green, irregular, to 45–95 μ diam., the cells slightly swollen, to 0.8–1.5 diameters long; holdfasts apparently absent.

Reference: Taylor, 1937, p. 83.

Chile: Arica, *Hassler 7, 8*, 1872.

BRYOPSIDACEAE

BRYOPSIS RHIZOPHORA Howe. — Peru: Salaverry, along the shore, *Schmitt 566*, *567*, Oct. 18, 1926; *ibid.*, south of the pier, *Schmitt 569*, Oct. 19, 1926.

Reference: Howe, 1914, p. 38, pl. 6, fig. A; pl. 7.

BRYOPSIS ROSAE Gaud. — Chile: Arica, *Hassler 6*, 1872.

References: Bory de St. Vincent, 1827–29, p. 211, pl. 24, fig. 1. Hooker *f.* and Harvey, 1847 (II), p. 492. Hylmö, 1919, p. 14. Taylor, 1939, p. 135.

Bryopsis peruviana, sp. nov. — Plants dark green, to 7 cm. tall or perhaps somewhat more, gregarious, at the bases erect or somewhat entangled, the holdfasts lobed, somewhat rhizoidal; the erect axes to 680–770 μ diam., simple or generally in the lower portion sparingly branched, the branches erect or ascending, similar to the axes; branches distally distichously beset with short pinnules, forming narrow very acute-tipped blades, which become 2.5 cm. long, 5 mm. broad, the pinnules ascending, slightly upcurved, to 3.5 mm. long, reaching 130–200 μ diam., or to 250 μ when bearing a few small secondary pinnules; branches at the base often bearing a few short, decurrent rhizoids, but without extensive rhizoidal cortication. Plate II, Figure 1.

Peru: Paita, *Hassler 80* (TYPE), *94*, 1872.

Plantae atrivirides, plus minusve 7 cm. altae, gregariae, erectae vel deorsum intertextae, hapteris lobatis vel paulum rhizoidalibus; axibus plerumque 680–770 μ diam., simplicibus vel in parte inferiore sparse ramosis, sursum distiche vestitis cum pinnulis brevibus 130–200 μ diam., laminas angustas acutas formantibus; rhizoideis paucis, parvis, ad bases ramorum inferiorum sitis, haud corticem rhizoidalem formantibus.

Peru, in loco dicto Paita; legit "Hassler Expedition," *80*, 1872.

These plants differ from *B. corticulans* in their crowded growth habit, sparse erect branching, dark color and slight rhizoidal growth from the branches. In habit they exactly resemble specimens of *B. muscosa* Lamour., except for the strictly distichous blades and the small growths from the bases of the branches. In spite of Howe's warning (1914, p. 39), the writer feels that it is best to describe this plant as new.

CAULERPACEAE

Caulerpa flagelliformis C. Ag. f. ligulata (Harv.) Weber–van Bosse. — Peru: Islas Lobos de Afuera, on shore rocks, *Schmitt 391A–35*, Jan. 17, 1935; *ibid.*, dredged from 25–29 meters' depth in South Bay, *Schmitt 395A–35*, Jan. 17, 1935.

References: Harvey in J. Agardh, 1872, p. 10. Weber–van Bosse, 1898, p. 273, pl. 24, fig. 7. Howe, 1914, p. 42, pl. 8.

CODIACEAE

Codium Setchellii Gardn. — Chile: Tocopilla, *Schmitt 159*, Nov. 15, 1926.

References: Schmidt, 1923, p. 28. Taylor, 1939, p. 135.

Codium fernandezianum Setch. — Chile: Islas Juan Fernandez, *Hassler*, det. Setchell.

Reference: Setchell, 1937, p. 592, pls. 35–38; text figs. 15, 41–48.

Codium peruvianum (Howe) Setch. — Peru: Paita, *Hassler 93* (?), 1872; *ibid.*, rocks north of the railroad station, *Schmitt 547*, Oct. 6, 1926; *ibid.*, dredged offshore north of the town, *Schmitt 555*, Oct. 7, 1926. Islas Lobos de Afuera, shore rocks, *Schmitt 391D–35*, Jan. 19, 1935.

References: Howe, 1914, p. 43, pl. 9. Setchell, 1937, p. 597.

Codium unilaterale Setchell & Gardn. f. Skottsbergianum Setchell. — Chile, Islas Juan Fernandez, *Hassler*, 1872, det. Setchell.

Reference: Setchell, 1937, p. 596, pl. 38, fig. 16.

PHAEOPHYCEAE

CHORDARIACEAE

Myriocladia grandis Howe. — Peru: Callao, dredged from 5.4 meters' depth near Isla San Lorenzo, *Schmitt 364C–35*, Jan. 10, 1935.

Reference: Howe, 1914, p. 53, pls. 12–13, figs. 10–20.

ASPEROCOCCACEAE

Colpomenia sinuosa (Roth) Derb. & Sol. — Peru: Paita, dredged off the shore north of the town, *Schmitt*, Oct. 7, 1926. North

Chinchas Island, Chicago Nat. Hist. Mus., *1013285*. Bahía Independencia, dredged from 9 meters' depth east of Isla Vieja, *Schmitt 371B–35*, Jan. 12, 1935.

References: Howe, 1914, p. 50. Taylor, 1928, p. 110.

COLPOMENIA SINUOSA f. **lacunosa** f. nov. — Plants forming cushions 1.0–1.5 cm. thick and 2–5 cm. or more broad, dull brownish, darkening on drying; thallus very irregular, of divisions 2–5 mm. broad, in the lower parts becoming lacunose, above the surface irregular with short projecting lobes or free branches about as long as broad, or the branches coherent; surface cells angular, 4.5–10.0 μ diam., from alcoholic material, the thallus wall about 350–400 μ thick, the inner medullary cells in 2–3 layers and very large, the outer medullary cells sharply smaller, in 2–3 layers of equally colorless cells; cortex a single layer of chromatophore-rich cells, about 6–9 μ tall, about as broad or a little less.

Peru: *Hassler 84, 107*, 1872; *ibid.*, rocks north of the railroad station, *Schmitt 541* (TYPE), Oct. 6, 1926. Bahía Independencia, from the shore, *Schmitt 380A–35*, Jan. 14, 1935.

Plantae caespitosae, caespites 1.0–1.5 cm. crassos, 2–3 cm. latos integrantes; thallo irregulari, divisionibus 2–5 mm. latis, in parte inferiore lacunoso et lobis divergentibus vel ramis liberis latitudine longitudinem aequantibus praedito.

Peru, in loco dicto Paita; legit Schmitt, *541*, 1926.

This plant is a very puzzling one. It was at first taken for *Hydroclathrus clathratus* (Bory) Howe, which has been reported from Peru (Skottsberg, 1941, p. 683, but not Howe, 1914). However, it is smaller and more compact; there is no large, well-developed net system such as is evident in good Hydroclathrus, and free terminal lobes are common, if small. It may be compared with *Colpomenia ramosa* Taylor (1945, p. 84) from Baja California and Costa Rica, but it is a much more compact plant, lacunose below, and the free surface branches are very much shorter and simpler. A form parallel to this one is *Colpomenia sinuosa* f. *tuberculata* (Saund.) Setchell & Gardner (1925, p. 541; Phyc. Bor.-Amer. *826*), but that is more minutely divided and thicker-walled. Unfortunately, little but dried material was available and, since the form is not restored on soaking, it is not practicable to give good habit illustrations of it.

SPHACELARIACEAE

HALOPTERIS HORDACEA (Harv.) Sauv. — Chile: Antofagasta, washed ashore in tidal pools on the rocky coast, *H. H. Bartlett 19020*, Sept. 9, 1942. Plate I, Figure 1; Plate III.

References: Harvey, 1844, pl. 614 (as *Sphacelaria hordacea*). Reinke, 1890, p. 27, pl. 7, figs. 6–9 (as *Stypocaulon paniculatum*). Sauvageau, 1900–14, pp. 416–433. (Perhaps *Sphacelaria paniculata* Suhr, 1840, p. 278, regarding which see Sauvageau, *loc. cit.*)

A considerable amount of this plant was secured. The largest piece was 36 cm. tall. The habit varied a good deal. The upper branching of young plants was corymbiform and somewhat resembled *H. scoparia* (Kütz.) Sauv. Fertile plants were paniculate, not corymbiform, in aspect; they were sometimes dense and with very dense fruiting tips; these were sporangial plants. Other looser ones were presumably sexual, but the reproductive organs were not clearly preserved in this rough-dried material. The fertile portions of the plants are the ends of tertiary branches. Here the branchlets are tetrastichous, but are deflected sharply to the left and especially in sporangial individuals curve partly around the axis, producing a most distinctive strobilar structure. In the axil of each branchlet there is a cushion of tissue on which develop a considerable number of sessile unilocular sporangia. This plant has previously been regarded as native only to Australia and New Zealand, and its discovery on the American continent is of very considerable interest.

DICTYOTACEAE

SPATOGLOSSUM VELEROAE Taylor. — Peru: Islas Lobos de Afuera, on the shore rocks, *Schmitt 391E–35*, Jan. 17, 1935.

Reference: Taylor, 1945, p. 92, pl. 12.

These specimens are smaller than most of the Galápagos plants, reaching a height of but 18 cm.

GLOSSOPHORA KUNTHII (C. Ag.) J. Ag. — Peru: Paita, *Hassler 1099; ibid.*, dredged offshore north of the town, *Schmitt 556A*, Oct. 7, 1926. Callao, dredged off Isla San Lorenzo, *Schmitt 207*, Nov. 7, 1926. Chile: Pisagua, Paessler, Herbarium Taylor, *5177*, 1902. Antofagasta, *Schmitt 140* (highly proliferous), Nov. 15, 1926.

Reference: Howe, 1914, p. 72, pl. 28.

The proliferous character ascribed to this species is apparently due to the habitual production of minute plantlets from the scattered reproductive organs. Some specimens seen were nearly smooth; others were densely covered with small blades up to 1–2 mm. long, but rarely more.

DICTYOPTERIS COKERI (Howe) Taylor. — Peru: Paita, dredged offshore north of the town, *Schmitt 556B*, Oct. 7, 1926.

References: Howe, 1914, p. 70, pl. 13, figs. 5–9; pl. 27 (as *Neurocarpus Cokeri*). Taylor, 1945, p. 95, pl. 14, fig. 1.

DESMARESTIACEAE

DESMARESTIA MUNDA Setch. & Gardn. — Peru: Paita, *Hassler 116, 120*, 1872. Bahía Independencia, dredged from 9 meters' depth, *Schmitt 382C–35*, Jan. 14, 1935.

References: Setchell and Gardner, 1925, p. 567, pl. 89. Taylor, 1945, p. 108.

This vigorous form, previously known from the North Pacific, has recently been reported by the writer (*loc. cit.*) from moderately deep water off Ecuador; the exact depth from which the present specimens were dredged is not recorded, but at any rate they came from much farther south, in cooler seas.

LAMINARIACEAE

EISENIA COKERI Howe. — Peru: Paita, *Hassler 126*, 1872; *ibid.*, Callao, mature sporophylls, *Schmitt 215A*, Nov., 1926; *ibid.*, dredged off Isla San Lorenzo, *Schmitt 214* (mostly juvenile stages), Nov. 7, 1926. Plate IV.

Reference: Howe, 1914, p. 55, pl. 14, fig. A; pls. 15–16.

The available material includes plants considerably younger than Howe had, as well as mature blades. The primary blade becomes at least 9 cm. wide and 25 cm. long (dried) before decay at the tip is well established, but by that time the basal pinnae are well over 1 dm. long (incomplete). In a specimen with primary blade 6.5 cm. wide and 16 cm. long (dried) the longest basal pinna was only about 1 cm. The first formed upper pinnae are hardly more than triangular teeth; those produced a little later are sharply upcurved and have a broad base, whereas the ones formed from the meristem when it has begun to function well taper to a

narrow base. There is no suggestion that the plant could at any stage resemble *Laminaria biruncinata* Bory (Bory de St. Vincent, 1827–29, p. 101, pl. 10), to which, however, the writer's *Eisenia galapagensis* (1945, p. 101, pls. 20–22) bears a slightly greater resemblance.

Macrocystis pyrifera (L.) C. Ag. — Peru: Punta Lomas, Fairchild, Herbarium Taylor, *6998*, 1899. Bahía Independencia, dredged from 9 meters' depth, *Schmitt 382B–35*, Jan. 14, 1935.

Reference: Setchell and Gardner, 1925, p. 627, pls. 64–65.

The material from Punta Lomas showed both tip and older blades; they had quite evident short teeth. The terminal blade was relatively broad.

Lessonia nigrescens Bory. — Chile: Caldera, juvenile and mature plants, *Hassler 1132*, 1872. Valparaiso, juvenile plants, Harshberger, Herbarium Taylor, *13223*, Aug. 16, 1927. Prov. Cautin, *Hollermayer 186K*, 1919.

The younger plants, which are complete and to over 7 dm. tall (dried), show blades 1.5–4.0 cm. wide before being divided, the margins in the wider ones from Valparaiso being smooth to minutely denticulate. Division begins at the basal meristem and produces two apparently equal blades, but one may redivide considerably before the other. The older specimen from Caldera has an extensive heavy branched portion reaching, when dried, a diameter of over 1.5 cm., whereas the blades above hardly reach 5 mm. The Cautin specimen is exceedingly slender, the dried blades only 2–3 mm. wide and rather short; it may represent *L. Suhrii* J. Ag. (Howe, 1914, p. 60).

Macrocystis integrifolia Bory. — Chile: Antofagasta, Harshberger, Herbarium Taylor, *13222*, *13224*, Aug. 19, 1927. Caldera, *Hassler 1133*, 1872.

References: Howe, 1914, p. 60, pls. 20, 22. Setchell and Gardner, 1925, p. 628, pl. 62. Smith, 1944, p. 143, pl. 26.

The Caldera material shows excellently the characteristic rhizomatous holdfast in a young specimen. The Antofagasta material is from older plants, and basal parts are lacking. The narrow blades topped long, narrow, downwardly tapering bladders. These blades have much longer filiform teeth than those from Caldera, reaching 4 mm., but the terminal blade is relatively narrow, and so the determination seems certain.

RHODOPHYCEAE

BANGIACEAE

PORPHYRA KUNTHIANA Kütz. — Peru: Punta Talara, *Schmitt 166*, Aug. 29, 1926. Paita, rocks north of the railroad station, *Schmitt 544*, Oct. 6, 1926. Salaverry, along the shore, *Schmitt 561*, Oct. 18, 1926. Prov. Chancai, *Maldonado 120C*, Feb., 1942. Herradura, *Schmitt 177*, Oct. 31, 1926. Chile: Caldera, *Hassler 1131*, 1872.

References: Kützing, 1869, p. 30, pl. 84. Howe, 1914, p. 74.

The monostromatic blades in this material varied much in size and shape. Some were as narrow as 5 mm., with a length of 19 cm.; others were 1 cm. wide and 21 cm. long; still others were subcordate and 3 cm. broad, 9 cm. long, from which apparently the shape varied to strongly cordate blades as broad as long, or broader, with the greatest width about 9 cm. The thickness in ours is often considerably less than the 60 μ allowed by Howe, and none of our material reached his greatest dimension, but the characteristic thick outer wall with cells equal or a half taller than broad were distinctive features in all recorded here.

PORPHYRA UMBILICALIS (L.) C. Ag., *prox.* — Plants becoming deeply cordate or subumbilicate, to 10 cm. broad, 13 cm. long, or relatively even wider; monostromatic; thickness to 45–60 μ, cells in section 1.75–2.5 times as tall as broad; outer and lateral walls moderately thick.

Peru: Salaverry, along the shore, *Schmitt 562*, Oct. 18, 1926. Chile: Valparaiso at Torpederas, in the littoral, where reported eaten by the poorer people and called "luche," *Schmitt 250*, Jan. 6, 1927. It is unlikely that the natives would distinguish between this and *P. Kunthiana*, for which Valparaiso is the type locality (Howe, 1914, p. 74).

References: Taylor, 1937, p. 221, pl. 30, figs. 1–3; 1939, p. 141.

These plants are distinguishable in section by reason of the tall cells which compose the single layer, covered with a matrix relatively much thinner than that in *P. Kunthiana*. This may be what has passed as *P. umbilicalis* from Pacific South American waters, but the cells seem taller than those in the plants of this species familiar to the writer in the North Atlantic.

GELIDIACEAE

GELIDIUM CRINALE (Turn.) J. Ag. — Chile: Bahía Arica, *Hassler 4*, 1872.

Reference: Taylor, 1937, p. 246, pl. 35, figs. 1–3.

This is the terete plant from the southern waters, and it is ordinarily and probably correctly referred to under this name. Accompanying it, and probably mistaken for it, is a similar or an even smaller plant with flat branches. Since this was sterile in the collections available, no identification is offered. It resembled *Pterocladia musciformis* Taylor (1945, p. 159), but the structure was not so clearly identical that these flat plants could be referred to that species.

GELIDIUM FILICINUM Bory. — Peru: Paita, *Hassler 79*, *112* (tetrasporic and cystocarpic), 1872.

References: Howe, 1914, p. 97. Taylor, 1945, p. 158.

Howe (*loc. cit.*) had only fragmentary material for his study, but the present material is of good size, reaching a height of 12 cm. His description is accurate in most points. On these larger plants, however, the pinnate branching goes well beyond three orders. The ultimate flat branchlets are sharply rather than obtusely dentate when magnified enough to make this feature visible; there are about 6–10 sharp teeth per millimeter. Howe discusses the relation of his plant to *G. lingulatum* J. Ag. (Kützing, 1868, pl. 65, figs. A–C). The writer finds that the plant Kützing figured had much more erect, sparingly divided branches and looked quite unlike the present specimens. Plate V, Figure 2.

Gelidium congestum, sp. nov. — Plants small, to 4 cm. tall, the terete base briefly flagelliferous, attaching by frequent short irregularly disciform holdfasts; erect axes somewhat clustered, terete at the bottom only, soon expanding to 0.5–1.0 mm. broad, 125–180 μ thick; axes at first simple, strap-shaped, remaining simple, or very sparingly branched for about 2 cm. in full-grown plants, marginal branching close above, irregularly alternate or in the uppermost parts irregularly cervicorn to digitate, and sometimes sparingly proliferous from the face, the divisions 0.1–0.5 mm. wide, flat to compressed in the smallest parts, entire-margined or appearing irregularly aculeate-toothed by the projection of new branch rudiments; in section the rhizines appearing widely

distributed but chiefly subcortical; surface cells in surface view 3.5–5.0 μ diam., with thick lateral walls. Plate VI.

Peru: Salaverry, along the shore, *Schmitt 563*, Oct. 18, 1926; *ibid.*, south of the pier, *Schmitt 570*, Oct. 19, 1926 (TYPE).

Plantae usque ad 4 cm. altae, ad basim teretem breviter flagelliferae, hapteris disciformibus adnatae; axibus propinquis, deorsum teretibus, simplicibus vel sparse ramosis, sursum applanatis, minus quam 0.5–1.0 mm. latis, 125–180 μ crassis, aut dense in marginibus irregulariter alternate ramosis aut ex faciebus irregulariter ramos cervicorniculatos vel digitatos ferentibus aut sparse proliferentibus cum divisionibus ultimis 0.1–0.5 mm. latis, compressis vel subteretibus.

Peru, in loco dicto Salaverry; legit Schmitt, *570*, 1926.

CORALLINACEAE

MELOBESIA MARGINATA Setchell & Foslie. — Peru: Paita, on Gracilaria, *Hassler 109, p. p.*, 1872.

References: Setchell and Foslie in Nichols, 1909, p. 350 (as *Lithothamnion marginatum*). Taylor, 1945, p. 176.

CORALLINA CHILENSIS Decaisne. — Peru: Callao, dredged off Isla San Lorenzo, *Schmitt 215*, Nov. 7, 1926; *ibid.*, on Isla San Lorenzo, *Schmitt 192*, Nov. 3, 1926. Chile: Antofagasta, *Schmitt 136, 139*, Nov. 15, 1926. Lota, *Hassler 1137*, 1872. Plate VII.

References: Howe, 1914, p. 178. Taylor, 1945, p. 200, pl. 62.

The writer has already remarked (*loc. cit.*) on the peculiarities of this material and compared it with Mexican and Ecuadorian plants which may belong to the same species. The illustration he gave from Mexican material represents a type with considerably flattened segments; that distributed by Areschoug (Phyc. Extra-Europ. Exsic. 68), a more terete one. At the moment there are no criteria for a specific distinction between these. Howe deals with the taxonomic history of this plant, which the present writer feels it is necessary to distinguish from *C. officinalis* and so uses the name *C. chilensis*, in spite of its somewhat uncertain application.

CORALLINA OFFICINALIS L. — Peru: Salaverry, *Schmitt 171*, Oct. 19, 1926. Bahía Independencia, from the shore on the east side, *Schmitt 380–35*, Jan. 14, 1935.

References: Howe, 1914, p. 179 (as *C. officinalis* var. *collabens*). Taylor, 1939, p. 143.

This may well be the same plant as that designated var. *collabens* by Howe (*loc. cit.*), but, if so, the writer sees no advantage in the varietal designation. In the present material the marginate character is not evident, and calcification is complete. It would be hard, if not impossible, to distinguish this from some shallow-water New England material, or some the writer has reported from southern Chile.

GRATELOUPIACEAE

Halymenia foliacea, sp. nov. — Plant foliaceous, to 11 dm. tall, moderately thin, dark, somewhat brownish red (from preserved material); the stipe very small and slender, the blade lanceolate, or the base from cuneate later to transverse or subcordate, the margins entire to obscurely crenate, the acute apex simple to 1–3 times forked; occasionally marginally proliferous near the base; thickness (soaked up) to 120–215 μ; medulla of numerous filaments about 4–8 μ diam., occasionally near the cortex with very inconspicuous stellate cells 15–22 μ diam., with 4–6 attaching filaments not visible through the cortex; subcortex loose, of 2–3 layers of rounded cells about 8–20 μ diam., the outer cortex of a close layer of rounded cells in section 1.5–2.0 times as tall as broad, 6–8 μ diam., in surface view appearing irregularly rounded, 6–10 μ diam., somewhat grouped in twos or fours, the intercellular and the outer walls moderately thick; spermatangia borne 2–3 on a cortical cell, cut off by oblique walls, 4–5 μ diam.; cystocarps very numerous, evenly distributed, about 0.5 mm. diam. Plate VIII, Fig. 2.

Peru: Callao, dredged off Isla San Lorenzo, *Schmitt 213* (spermatangial), Nov. 7, 1926; *ibid.*, from 5.4 meters' depth, *Schmitt 364D–35* (cystocarpic), Jan. 1, 1935 (TYPE). Islas Chinchas, dredged from 14 meters' depth, *Schmitt 386A–35*, Jan. 15, 1935.

Plantae foliaceae, grandiores 11 dm. altae, stipite parvo; lamina lanceolata basi cuneata vel subcordata, margine integra plana vel vix crenata, apice simplici vel furcata, crassitudine plantae madefactae plerumque 120–215 μ in plantis grandioribus; medulla ex

filamentis numerosis constante raro prope corticem cellulis stellatis praedita; cystocarpiis numerosis, aequabilibus, ca. 0.5 mm. diam.

Peru, in porto dicto Callao; legit Schmitt, *364D–35*, 1935.

From Howe's Peruvian *H. tenera* (1914, p. 159) this species differs in its more elongate shape, greater thickness and loose inner medulla. One should note, however, that the sections frequently resisted expansion from the dried state, and one might readily get the false impression of a compact medulla. It is larger and thicker than any species described from Ecuador by the author. It is thinner and has a thinner surface jelly than *H. abyssicola*, described from a fragment by Dawson (1944, p. 278).

GRATELOUPIA CUTLERIAE Kütz. — Peru: Paita, *Hassler 122*, 1872.

Reference: Howe, 1914, p. 166, pls. 59–60 (f. *procera*).

GRATELOUPIA DENTICULATA Mont. — Fragments of the upper parts of plants measuring to 30 cm. long, 27 mm. broad (dried), branching to four degrees, the segments strap-shaped, tapering upward to sharp ends, fleshy, blackish brown as dried; margins closely beset with simple or 2–3-forked aculei to 2 mm. long; surface abundantly beset with slightly shorter aculei; sections about 650 μ thick, the inner medulla of moderately close interweaving but chiefly longitudinal filaments 4–9 μ diam.; the outer medulla 110 μ thick, of anticlinal branching cell series 10–12 cells long, moderately easily dissociated by pressure, the inner cells nearly isodiametric or radially a little elongated, about 10×15 μ diam., laterally not contiguous, the outermost cells about 6×8 μ diam., a little subquadrate-compressed laterally with thin walls; externally the jelly only moderately thick. Plate IX, Figure 2.

Peru: Paita, *Hassler 127*, 1872, det. Setchell and Gardner.

References: Montagne, 1846, p. 145. Howe, 1914, p. 170.

GRATELOUPIA DORYPHORA (Mont.) Howe. — Peru: Callao, *Maldonado 305*, June, 1942, det. Setchell.

References: Montagne, 1839, p. 21 (as *Halymenia doryphora*). Howe, 1914, p. 169, fig. 43.

Fragments only in the piece seen by the author, and very narrow at that, indeed in part sublinear. The histology seemed to agree, however, with Howe's specifications.

GRATELOUPIA SCHIZOPHYLLA Kütz. — Peru: Salaverry, along the shore, *Schmitt 560*, Oct. 18, 1926; *ibid.*, on wreckage, *Schmitt 576*,

Oct. 21, 1926. Callao, from Isla San Lorenzo, *Schmitt 186*, Nov. 1, 1926.

References: Howe, 1914, p. 168, pls. 61–62. Kützing, 1867, p. 11, pl. 36.

Prionitis decipiens (Mont.) J. Ag. — Peru: Punta Talara, *Schmitt 168*, Aug. 29, 1926, det. Setchell and Gardner. Paita, dredged from offshore north of the town, *Schmitt 552*, Oct. 7, 1926.

Reference: Howe, 1914, p. 174, pl. 64.

SEBDENIACEAE

Sebdenia (?) chichensis, sp. nov. — Plants foliaceous, to 21 cm. tall, the texture membranous, when dried subnitent, adhering poorly to paper except in the youngest portions; from a small holdfast and short slender stalk gradually cuneate-expanded to a blade which reaches a width of 2.5–4.5 cm., branching 1–3 times subdichotomously or palmately from the margins, the tips broadly rounded, minutely retuse at the growing point, below alternately expanded and contracted to as little as one third of the width in the adjacent broad portions, the margins otherwise obscurely crenate and crisped; thickness to 75 μ (perhaps incompletely expanded); the cuticle firm, to 4–5 μ thick; cortex irregular, about 10–15 μ thick of 1–2 layers, in surface view the cells 4–15 μ diam., angular and with firm walls between, in section rounded, 5–9 μ diam.; subcortical layer of scattered colorless rounded cells but little larger; medulla (perhaps poorly expanded) thin, of moderately close-placed filaments, some thin-walled, but numerous others markedly refractive though obscure when seen in surface view, anatomosing but not clearly forming stellate ganglionic junctures; reproduction not seen. Plate X, Figure 1.

Peru: Islas Chinchas, *Schmitt 390D–35*, Jan. 15, 1935.

Plantae foliaceae longitudine usque ad 21 cm., membranosae; haptero parvo; stipite brevi gracili sursum gradatim applanato; lamina 2.5–4.5 cm. lata, semel, bis vel ter ex margine subdichotome vel palmatim ramosa; ramis apice late rotundatis et minute retusis, deorsum longo intervallo repetiter angustatis et expansis, crassitudine 75 μ; medulla constante ex filamentis modice densis interdum refractivis, anastomosantibus sed non figuras stellatas formantibus.

Peru, in insulis dictis Islas Chinchas; legit Schmitt, *390D–35*, Jan. 15, 1935.

In general structural features these plants resemble *392A–35*, but are thinner and with a different cortex, less medulla, and less evident refractive filaments. It is difficult to imagine the very striking form of the thallus as an immaterial variant of any of the other known Peruvian or Chilean Sebdeniae or Halymeniae.

Sebdenia (?) afuerensis, sp. nov. — Plant subfoliaceous, to 18 cm. tall, the texture firmly membranous, when dried hardly nitent, adhering poorly to paper; from a small holdfast developing a compressed axis which may divide once or twice successively, above strap-shaped, expanding gradually to 1–2 cm. in width and branching 2–3 times successively irregularly to subdichotomously from the margin, somewhat narrowed toward the rounded tips, the margin irregular; thickness to 130 μ in younger parts, to 140 μ in the older blades; the cuticle not specially thick; cortex irregular, the cells round to oval, usually in one layer, in section 4–6 μ deep and slightly narrower, in surface view round to oval, 3–7 μ diam., the lateral walls refractive and relatively thick, to 1.5–3.0 μ; subcortical layer 12–15 μ thick, of 1–2 layers of rounded cells 7 μ diam. or transversely oval, to 7 × 15 μ diam.; medulla not sharply delimited in older parts, more clearly so in the younger, in which it consists of many slender filaments and, interspersed, numerous others without evident lumen, to 7 μ diam. and much more refractive, from the surface seen to be obviously anastomosed with enlarged junctures reaching 50–70 μ diam., few to several filaments radiating from each; in older parts the ordinary filaments 3–5 μ diam. with thick obviously coalescent walls, the refractive filaments somewhat larger; reproduction not seen. Plate X, Figure 2.

Peru: Islas Lobos de Afuera, dredged from 36–40 meters' depth in North Bay, *Schmitt 392A–35*, Jan. 17, 1935 (TYPE).

Planta subfoliacea, altitudine minus quam 18 cm., firme membranaceae; hapteris parvis; axe ad basim tereti, semel vel bis diviso, divisionibus deorsum liguliformibus et gradatim expansis in laminas 1–2 cm. latas, usque ad 140 μ crassas, irregulariter ex margine bis vel ter ramificantes, apicibus angustatis rotundatisque; medulla constante ex filamentis specierum duarum, videlicet, ordinariis 3–5 μ diametientibus, aliisque valde lucem

refringentibus, diam. 7 μ, ex superficie obvie anastomosantibus ganglia 50–70 μ diam. formantibus; in partibus vetustioribus frondis filamentis ordinariis incrassatis et inter se coalescentibus.

Peru, in insulis dictis Islas Lobos de Afuera; legit Schmitt, *392A–35*, 1935.

These plants are very suggestive of *Sebdenia limensis* (Sond.) Howe (1914, p. 160; Kützing, 1866, pl. 79, as *Halymenia limensis*), but are much more branched and with narrower segments. From *S. limensis* their much wider medulla also probably distinguishes these plants. Unfortunately, they are nearly covered with bryozoa, and so the exact habit is obscured. A certain similarity to *Halymenia leiphaenia* Montagne (1839, pl. 6, fig. 2) caused that species to be considered, but it is more flabellately branched; we do not know its structure. Howe's plant (1914, p. 163, pl. 58) does not seem to have a stalklike portion below and is broader and markedly marginally proliferous.

Sebdenia lapathifolia (Kütz.) Howe. — Peru: Paita, *Hassler 121* (cystocarpic), 1872.

References: Kützing, 1866, pl. 99 (as *Halymenia lapathifolia*). Howe, 1914, p. 162.

The plant assigned to this species was about 45 cm. long, 7.5 cm. wide. The base was very slender, sharply cuneate-expanded, and subreniform, thence gradually lanceolate. When the sections were fully restored to shape the medulla was loose, and the thickness reached 250 μ.

CALLYMENIACEAE

Callophyllis variegata (Bory) Kütz. — Peru: Bahía Independencia, dredged from 9 meters' depth east of Isla Vieja, *Schmitt 371C–35*, Jan. 12, 1935. Chile: Isla Chiloë, at San Pedro, *Hassler 1135*.

Reference: Howe, 1914, p. 119.

SOLIERIACEAE

Agardhiella tenera (J. Ag.) Schmitz. — Peru: Paita, *Hassler 123* (cystocarpic), 1872. Callao, at Isla San Lorenzo, *Schmitt 195*, Nov. 3, 1926. Bahía Independencia, dredged from 9 meters' depth, *Schmitt 382A–35*, Jan. 14, 1935.

References: Howe, 1914, p. 119, pl. 47. Taylor, 1937, p. 286, pl. 38, fig. 4; pl. 41, fig. 2; pl. 59, fig. 9; 1945, p. 222.

PLOCAMIACEAE

PLOCAMIUM COCCINEUM (Huds.) Lyngb. — Chile: Tocopilla, *Schmitt 156*, Nov. 15, 1926.

Reference: Kylin and Skottsberg, 1919, p. 30.

PLOCAMIUM SECUNDATUM Kütz. — Chile: Caldera, *Hassler 1125*, 1872.

References: Kylin and Skottsberg, 1919, p. 31, fig. 16. Taylor, 1939, p. 144.

GRACILARIACEAE

GRACILARIA LEMANAEFORMIS (Bory) Weber-van Bosse. — Peru: Paita, *Hassler 110* (cystocarpic), 1872.

References: Howe, 1914, p. 128, pl. 52 (as *Cordylecladia lemanaeformis*); Weber-van Bosse, 1913–28, p. 435.

GRACILARIA PERUANA Picc. & Grun. — Peru: Paita, *Hassler 105*, *129*, 1872 (det. Howe); *ibid.*, *Schmitt 165*, Oct. 6, 1926; *ibid.*, rocks north of railroad station, *Schmitt 543*, Oct. 6, 1926; *ibid.*, dredged offshore, *Schmitt 551*, Oct. 7, 1926.

References: Piccone, 1886, p. 70. Howe, 1911, p. 505; 1914, p. 123.

PHYLLOPHORACEAE

AHNFELTIA DURVILLAEI (Bory) J. Ag. — Peru: Punta Talara, *Schmitt 167*, Aug. 29, 1926. Paita, dredged just north of the town, Schmitt, Oct. 7, 1926. Islas Lobos de Afuera, *Schmitt 391B–35*, Jan. 17, 1935. Salaverry, *Schmitt 167B*, Oct. 18, 1926. Islas Chinchas, at North Chincha Island, K. P. Schmidt, Nov. 1, 1939. Prov. Chancai, *Maldonado 120A*, Feb., 1942.

Reference: Howe, 1914, p. 110, pls. 44, 46.

AHNFELTIA SETACEA (Kütz.) Schmitz. — Chile: Corral, Herbarium Taylor *4746* (originally as *Gymnogongrus furcellatus*), det. Setchell and Gardner.

Reference: Kützing, 1869, p. 15, pl. 67, fig. 2.

GYMNOGONGRUS DISCIPLINALIS (Bory) J. Ag. — Peru: Salaverry, along the shore, *Schmitt 565*, Oct. 18, 1926; *ibid.*, south of the pier, *Schmitt 568*, Oct. 19, 1926. Callao, from Isla San Lorenzo,

190 (cystocarpic), *194*, Nov. 1, 3, 1926. All det. Setchell and Gardner.

Reference: Howe, 1914, p. 109, pl. 43.

GYMNOGONGRUS FURCELLATUS (C. Ag.) J. Ag. — Peru: Paita, *Hassler 89*, 1872, det. Setchell and Gardner. Callao, on Isla San Lorenzo, *Schmitt 191*, Nov. 1, 1926. Chile: Isla Chiloë, Herbarium Taylor *4748* (originally as *Chondrus violaceus*), det. Setchell and Gardner.

Reference: Howe, 1914, p. 107, pl. 42.

GIGARTINACEAE

GIGARTINA CHAMISSOI (C. Ag.) J. Ag. — Peru: Paita, *Hassler 86*, *88*, *108*, 1872, det. Setchell and Gardner.

References: Pilger, 1908, p. 180. Howe, 1914, p. 99. Collins, 1915, p. 92.

GIGARTINA CHAUVINII (Bory) J. Ag. — Peru: Paita, dredged offshore north of the town, *Schmitt 554*, Oct. 7, 1926; *ibid.*, off rocks north of the railroad station, *Schmitt 548*, Oct. 6, 1926. Salaverry, on wreckage, *Schmitt 573*, Oct. 21, 1926. All det. Setchell and Gardner, and all at least in part cystocarpic. Callao, dredged off Isla San Lorenzo from 5 meters' depth, *Schmitt 364E–35*, *382D–35*, Jan. 10, 14, 1935; *ibid.*, *Schmitt 211*, Nov. 7, 1926, det. as a depauperate individual by Setchell and Gardner; *ibid.*, *Maldonado 301*, June, 1942, det. Setchell.

References: Bory de St. Vincent, 1827–29, p. 165, pl. 20. Howe, 1914, p. 101, pl. 38. Setchell and Gardner, 1933, p. 266.

Setchell and Gardner considered that *548*, *554*, and *573* were *Sphaerococcus Chauvinii* var. *angusta* Bory (1827, pl. 20, fig. 3), and perhaps they are, but their excessively soft texture was due to disintegration in the preservative.

GIGARTINA GLOMERATA Howe. — Peru: Herradura, *Vargasl 1246*, Oct. 25, 1938.

Reference: Howe, 1914, p. 103, pl. 39.

GIGARTINA LESSONII (Bory) J. Ag. — Peru: Paita, *Hassler 117*, 1872. Callao, small specimens from Isla San Lorenzo, *Schmitt 187*, *196*, Nov. 1, 3, 1926, det. Setchell and Gardner. Prov. Chancai, *Maldonado 120B*, Feb., 1942. Chile: Arica, *Hassler 5*, 1872. San Vincente, *Hassler 1136*, det. Setchell and Gardner.

References: Bory de St. Vincent 1827–29, p. 169 (as *Sphaerococcus Lessonii*). Howe, 1914, p. 100, pl. 37.

Gigartina paitensis, sp. nov. — Plant to 0.5–1.0 dm. tall, bushy, probably of rather soft fleshy consistency, the holdfast small, cushion-shaped, the axis terete and slender at the base, soon enlarging to 1.5–2.5 mm. diam., terete or compressed, branching alternately and somewhat bilaterally, with several secondary percurrent axes, in the lesser divisions narrowly pyramidal, the smaller branches tapering and the branchlets rather abruptly acute, even aculeate; reproduction not seen. Plate XI.

Peru: Paita, *Hassler 111*, 1872.

Plantae fruticulosae, 0.5–1.0 dm. altae, haptero parvo; axe ad basim tereti, gracili mox crescente ad diametrum 1.5–2.5 mm., tereti vel compresso, alternate subbilateraliter ramoso; ramis secundariis paucis percurrentibus; ramis minoribus angustatis et ultimis breviter acutis.

Peru, in loco dicto Paita; legit "Hassler Expedition," *111*, 1872.

These plants in their looser aspects remarkably resemble *Agardhiella tenera* when dried, but the gigartinaceous structure, with a filamentous medulla in which there are coarser and slenderer elements merging into a cortex of radial branching cell rows, is distinctive. The most obvious comparison is with *G. glomerata* Howe (1914, p. 103, pl. 39; pl. 41, figs. 1–11). Our plant is much larger and less densely branched, even in the most crowded example, and the branchlets are more acutely tapered.

Iridophycus Boryanum Setchell & Gardner. — Chile: Lota, *Hassler 1140*, 1872, det. Setchell.

References: Bory de St. Vincent, 1827–29, pl. 11, fig. 1A–C (as *Iridaea laminarioides*). Setchell and Gardner, 1937, p. 202.

Iridophycus ciliatus (Kützing) Setchell & Gardner. — Chile: Isla Chiloë, from San Carlos (old specimens originally as *Iridaea ciliata*), Herbarium Taylor *4757*, tetrasporic and cystocarpic, det. Setchell and Gardner. Plate IX, Figure 1.

References: Kützing, 1867, p. 4, pl. 10. Setchell and Gardner, 1937, p. 220.

Iridophycus laminarioides (Bory) Setchell & Gardner. — Chile: Lota, *Hassler 1141*, 1872, det. Gardner.

References: Bory de St. Vincent, 1827–29, pl. 11, fig. 1I D (as *Iridaea laminarioides*). Setchell and Gardner, 1937, p. 206.

RHODYMENIACEAE

Dendrymenia Corallina (Bory), comb. nov. — Peru: Salaverry, on wreckage off beach north of pier at station 17, *Schmitt 571*, Oct. 21, 1926. Islas Chinchas, dredged from 14 meters' depth, *Schmitt 386B–35*, Jan. 15, 1935. Bahía Independencia, dredged at 9 meters' depth, *Schmitt 382D–35*, Jan. 14, 1935. Plate VIII, Figure 1.

References: Bory de St. Vincent, 1827–29, p. 175, pl. 16 (as *Sphaerococcus Corallinus*). Howe, 1914, p. 124 *p. p.*, probably pl. 51, but not pl. 50 (as *Rhodymenia Corallina*). Dawson, 1941, p. 148, pl. 21, figs. 28–29 (as *Rhodymenia Corallina*).

Dawson (*loc. cit.*) is probably correct in considering this plant closely related to *Dendrymenia flabellifolia* (Bory) Skottsb., and if the genus Dendrymenia is to be maintained, the new combination must be made for the name. These specimens, some of relatively young though luxuriant plants, show but a short main axis. In others the erect axes reach two decimeters in height. The foliar divisions, however, are not so distinct as in *D. flabellifolia*, and the aspect is somewhat intermediate between Bory's plates 16 and 17, whereas Howe's *R. flabellifolia* and those plants which the writer ascribes to that species are much more congested than even Bory's plate 17 shows his plant to have been. Howe's *R. Corallina* in his plate 51 appears to the writer to have an erect axis.

CERAMIACEAE

Ceramium rubrum (Huds.) C. Ag. — Chile: Isla Chiloë, at San Pedro, *Hassler 1134*, 1872.

References: Howe, 1914, p. 156. Taylor, 1937, p. 340; 1939, p. 152.

This species has often been recorded from South America, and the writer has had considerable material of it from the Strait of Magellan, which certainly is not the segregate *C. pacificum* (Collins) Kylin. In the warmer Atlantic waters *C. rubrum* appears occasionally in a small form, but we have no report of it from the tropical American Pacific shores, nor of *C. pacificum*. The material listed above has numerous lower lateral branchlets; in this it somewhat resembles *C. pacificum*, but no more than many

North Atlantic specimens do, and it lacks the characteristic regular corymbose habit of perfect *C. pacificum.*

CENTROCERAS CLAVULATUM (C. Ag.) Mont. — Peru: Salaverry, along the shore, *Schmitt 564*, Oct. 18, 1926. Chile: Arica, a very small amount mixed with *Gelidium crinale*, *Hassler 4B*, 1872.

References: Howe, 1914, p. 158. Taylor, 1928, p. 189, pl. 28, figs. 6–7; 1945, p. 272.

GRIFFITHSIA CHILENSIS Mont. — Peru: Paita, on Corallina, *Hassler 92*, 1872. Callao, dredged off Isla San Lorenzo, *Schmitt 206*, Nov. 7, 1926. Chile: Antofagasta, on the holdfasts of Halopteris, scarce, *H. H. Bartlett 19022C* (polysporic), Sept. 9, 1942. Plate I, Figure 2.

References: Kützing, 1862, p. 7, pl. 21, figs. D–F. Howe, 1914, p. 149.

All the Peruvian material was sterile, like that collected by Coker, but is probably correctly attributed to this species. The Paita plant is short and stout, probably from shallow water, whereas the dredged Callao specimen is slenderer and laxer.

The Chilean specimens consisted of a very few filaments, but proved exceedingly important, for they bore sporangia, and no kind of fruit has hitherto been known in this species. There is no reason to suspect that they are anything else than Montagne's *G. chilensis.* Unilaterally on the distal ends of two or three somewhat shortened upper but not uppermost segments there occur stout lateral branches which sharply divide and redivide, producing a dense cluster of branchlets, the stout end cells of which are strongly incurved, whereas on the cells below these large numbers of sporangia occur. This structure corresponds to that of the subgenus Eugriffithsia of Feldmann-Mazoyer (1940, p. 407), so far as can be determined from the very scanty dried material, though with so limited material it was not possible to work out the exact cell sequence and position of the sporangia. This is apparently the first American record of this subgenus. However, another remarkable feature appears in that these sporangia become polysporic; there is no distinct four-celled stage, and though what appear to be fairly mature sporangia with six spores were seen, most that were half grown or larger quite clearly had eight spores, and no larger number was certainly seen. These sporangia measured 85–125 μ, rarely to 170 μ diam. Poly-

sporangia apparently have not previously been reported in Griffithsia.

PLATYTHAMNION ORBIGNIANUM (Mont.) Howe. — Peru: Callao, dredged off Isla San Lorenzo, *Schmitt 212*, Nov. 7, 1926. Bahía Independencia, dredged from 13 meters' depth, *Schmitt 376B–35*, Jan. 13, 1935.

References: Montagne, in D'Orbigny, 1839, p. 7, pl. 7, fig. 4. Howe, 1914, p. 154.

The cells of the oldest axes were subcylindrical, but those of intermediate size were considerably inflated above the middle, and here the lateral branchlets were attached. The septa at the ends were considerably narrower. Howe accepts Montagne's description of the cells as of "hourglass form," but the comparison is not good, for the cells are not all contracted at the middle, but, rather, inflated. The material was abundant and well preserved, though sterile.

PLEONOSPORIUM VENUSTISSIMUM (Mont.) De Toni. — Peru: Paita, *Hassler 81* (with sporangia). Callao, dredged off Isla San Lorenzo, *Schmitt 202*, Nov. 7, 1926.

References: Kützing, 1862, pl. 1, figs. A–B. Howe, 1914, p. 150.

DELESSERIACEAE

ACROSORIUM sp.? — Plants decumbent and attached below, mostly free above, to 5–7 cm. tall (or more?), irregularly palmately lobed, the lobes short and about 3–5 mm. wide, or to 3 cm. long and 3–7 mm. wide, simple or sparingly divided; thallus to three cells thick and 65 μ below, nearer the holdfast increasing in some to 130 μ, one cell thick above except at the veins, the cells of the major portion 32–60, rarely to 80 μ broad, 32–75, occasionally to 100–120 μ long; microscopic veins with a lens evident to near the tip, anastomosing, 32–64 μ broad, one or sometimes two cells wide, the cells 65–160 μ long; reproductive stages not seen.

Peru: Callao, dredged off Isla San Lorenzo, *Schmitt 208*, Nov. 7, 1926. Bahía Independencia, dredged east of Isla Vieja, *Schmitt 372A–35*, Jan. 12, 1935.

ACROSORIUM UNCINATUM (J. Ag.) Kylin. — Chile: Antofagasta, on the basal parts of Halopteris, *Bartlett 19021* (tetrasporic), Sept. 9, 1942.

References: Taylor, 1930, p. 632, pl. 39 (as *Nitophyllum uncinatum* (Turn.) J. Ag. Okamura, 1936, p. 786, fig. 379.

These were very minute specimens — only one or two centimeters high. The characteristic branching was recognizable only in the largest, the others appearing subdichotomous, and the hooked tips were not frequent. On several blades tetrasporangial sori were found in the center of terminal segments, or, rarely, were apparently left behind by further growth of the tip.

Cryptopleura cryptoneuron (Mont.), comb. nov. — Peru: Paita, *Hassler 87* (spermatangial), *113* (tetrasporic). Callao, dredged off Isla San Lorenzo, *Schmitt 209* (tetrasporic and spermatangial), Nov. 7, 1926. Plate XII.

References: Montagne, 1839, p. 33 (as *Aglaophyllum cryptoneuron*). Howe, 1914, p. 131, pl. 54 (as *Nitophyllum cryptoneuron*). Kylin, 1924, p. 81 (as *Hymenena cryptoneuron*).

The Hassler specimens in particular closely resemble Howe's figure (*loc. cit.*). The specimen in the herbarium of the New York Botanical Garden is well shown in this illustration; it is of a somewhat smaller plant than those here reported. Except for *465*, from Pisco, the specimens on the two pertinent sheets at the New York Botanical Garden appear to belong to another genus, and so probably do Schmitt's *208* and *372A–35*. The pale spots on the blades of Howe's plant are probably artifacts, not spermatangial sori; similar and sterile areas were seen in Delesseriaceae in the Schmitt collections. The plants show minute anastomosing veinlets barely visible to the unaided eye 1–3 cm. below the tips. The spermatangial and sporangial sori formed marginal bands, or rounded sori in marginal crisped lobules. In *113* marginal lobules were lacking, and the blades were narrower than in *209*, where they reached two centimeters in width above a fork in the lower part of the plant. Plants of this collection in the lowest portions near the holdfasts reached 355 μ in thickness, with the cuticle 5–10 μ thick, the one central layer of cells columnar and 125 μ thick, and with 2–3 surface layers of flattened cells on each side. In the upper part, where it was only 65–115 μ thick, there was only one cell layer, except that the veins were of three layers.

Cryptopleura peruviana, sp. nov. — Plants to 3 dm. tall, foliaceous, dull reddish purple; axes below somewhat thickened, stalklike, irregularly proliferating, above cuneate-expanded to broad ir-

regularly cleft blades, the divisions 1.0–2.5 cm. wide, distally narrower, some divisions, especially the sporangial ones, being ligulate, the apices rounded obtuse; margins somewhat irregular, essentially entire above, but in the central part often ruffled or bearing small lobules; surface dull, marked by numerous inconspicuous anastomosing veins; spermatangia and tetrasporangia on the marginal ruffles or lobules. Plate XIII, Figure 2.

Peru: Paita, *Hassler 128* (spermatangial and tetrasporangial), 1872 (TYPE).

Plantae usque ad 3 dm. altae, foliaceae, colore atriuscule vinaceae, superficie opaca haud nitida; axe tenui, incrassato, deorsum cuneate dilatato in laminas latas irregulariter fissas; divisionibus 1.0–2.5 cm. latas, sursum angustatis et aequaliter ligulatis, apicibus rotunde obtusis, margine irregularibus crispatisque vel in parte superiore integris cum venulis numerosis inconspicuis anastomosantibus ornatis; spermatangiis et tetrasporangiis in margine crispata vel marginis lobulis positis.

Peru, in loco dicto Paita; legit "Hassler Expedition," *128*, 1872.

The apical cells are obscure and divide obliquely and laterally; apparently intercalary divisions occur frequently. The thallus is one cell thick between the veins above, but because of the close approximation of the vein rudiments it generally appears two or more cells thick from the surface.

Hemineura Hassleri, sp. nov. — Plants to 15 cm. tall or more, dull red in color (as dried), base small, lobed, axis moderately stout and subterete below, several times branched, above flattened and denuded, expanding into the linear oblanceolate blades, which have evident midribs and irregular, rather coarsely dentate margins, alternately marginally freely branching; branches to 8–12 mm. wide (dried), moderately thin, with an evident midrib but without evident lateral veins, the margin irregularly dentate; reproduction in irregular ovate marginal lobules 0.5–2.5 mm. long, the tetrasporangia in large sori, one on each side of the midline of the lobule; the cystocarps 1–2, on the midline of the lobule or a subdivision of it. Plate XIII, Figure 1.

Peru: Paita, *Hassler 118* (tetrasporic, cystocarpic), 1872 (TYPE).

Plantae altitudine usque ad 11 cm., axe deorsum denudato, sur-

sum lineari-oblanceolato, cum margine tenui grosse dentato et veno conspicuo, alternate ex margine dense ramoso; ramis 8–12 mm. latis vena mediana praeditis sed absque venulis lateralibus; tetrasporangiis in soris magnis utrinque secus vena mediana lobulosum irregularium ovatorum marginalium 0.5–2.5 mm. longorum; cystocarpiis 1 vel 2, in linea media lobulorum primariorum vel secondariorum.

Peru, in loco dicto Paita; legit "Hassler Expedition," *118*, 1872.

The apical cells of these plants divided transversely by a lunate segment, and the primary axial rows of cells did not subdivide transversely, although eventually the secondary axes did. The tertiary axes only in part reached the margin and ramified chiefly on the lower side. The thallus developed one large-celled medullary layer and a single cortical layer on each face; the cells soon without definite order as viewed from the surface. The axis in section becomes 2–5 cells thick in the middle portion of the plant, but the cells are in no definite arrangement in section; there are only a few somewhat smaller cells among them near the center, but there is no abundance of rhizoidal cells. The midribs of the side branches and marginal lobules do not traverse the chief blades as distinct structures. These plants are much less branched above than *H. frondosa*, are smaller, duller, and more irregular than *H. Schmitziana*, and are distinguished from *H. Howellii* Taylor from Ecuador by the fact that the tetrasporic lobules are hardly if at all contracted at the base, and are centainly not stipitate, whereas the whole texture is much thinner.

RHODOMELACEAE

Laurencia paitensis, sp. nov. — Plants to 12 cm. tall or more, loosely branched, the axis subterete and to 3 mm. diam., tapering toward the base and the top of the plant; primary branching moderate at intervals of 1–2 cm., the branches like the axis; minor branching at intervals of 0.5–1.0 cm., these branchlets beset with a few very short truncate ultimate branchlets; medulla in section of very large thin-walled cells; cortex of cells as broad as deep or broader, and in surface view 22–30 μ wide, 2–5 times as long and somewhat tapering to the ends; tetrasporangia in the ultimate branchlets or

about their bases; sexual reproduction not seen. Plate V, Figure 1.

Peru: Paita, *Hassler 114* (tetrasporic), 1872 (TYPE).

Plantae altitudine usque ad 12 cm., laxe ramosae, subteretes, minus quam 3 mm. crassae, ex parte media utrinque angustatae; ramis primariis (majoribus) modice densis inter se 1–2 cm. distantibus; minore ramificatione densiore cum ramis inter se 0.5–1.0 cm. distantibus et singulatim paucis brevibus truncatis ramulis ultimis praeditis; tetrasporangiis aut in ramulis ultimis sitis vel circum eorum basim.

Peru, in loco dicto Paita; legit "Hassler Expedition" *114*, 1872.

This plant is similar to *L. crispa* Hollenberg (Smith, 1944, p. 378). The gross habit is quite different, for we have no evidence that the plant is tussock-forming; its growth appears to be loose and free. The minor branch and branchlet forms are similar, and the structure also is similar, though the surface cells, while nearly isodiametric in section, are in surface view broader and elongate.

POLYSIPHONIA SUBTILISSIMA Mont., *prox.* — Plants repent below, to at least 5 cm. tall in the erect portion, freely branched, the erect branches like the axis, the tips slightly corymbose; apices without trichoblasts, the apical cells evident; axis with four pericentral cells, ecorticate, to 100–125 μ diam. below, but about 50 μ diam. in the smaller branches, the segments 1–2 diameters long; tetrasporangia single in the upper segments, not markedly inflating them, and forming long series.

Peru: Islas Chinchas, dredged from a sandy bottom at 14–18 meters' depth near the northwest corner of Mid Island, *Schmitt 389A–35*, Jan. 15, 1935.

Reference: Taylor, 1937, p. 365.

These plants are a bit coarser than New England *P. subtilissima*, but in warmer waters there are other tetrasiphonous plants ascribed to this species which are likewise coarser. Perhaps there are several species with the same habit. Until they can be segregated this seems to be a suitable name for these specimens.

POLYSIPHONIA PANICULATA Mont. — Peru: Salaverry, on wreckage, *Schmitt 572*, Oct. 21, 1926. Paita, *Hassler 82*, *100; ibid.*, *Schmitt 572B*, Oct. 6, 1926. Callao, at Isla San Lorenzo, *Schmitt 188*,

Nov. 1, 1926. Chile: Arica, *Hassler 15–18*. Det. G. J. Hollenberg. Plate II, Figure 2.

Reference: Howe, 1914, p. 142.

PTEROSIPHONIA PENNATA (Roth) Falk. — Peru: Salaverry, on wreckage, *Schmitt 575* (tetrasporic), Oct. 21, 1926. Callao, from Isla San Lorenzo, *Schmitt 193*, Nov. 3, 1926. Plate XIV, Figure 2.

This material reached a height of about 6 cm.; in axis, and especially in branchlets it seemed stouter than a French specimen with which it was compared, and very much stouter and with relatively shorter branchlets than material from California (*Gardner 2524*) and Japan; nevertheless, no suitable characters were found to differentiate it.

PTEROSIPHONIA DENDROIDEA (Mont.) Falk. — Peru: Paita, *Hassler 78, 98*, 1872; *ibid.*, fragments dredged north of the town, *Schmitt 558*, Oct. 7, 1926. Callao, dredged off Isla San Lorenzo, *Schmitt 210*, Nov. 7, 1926.

References: Howe, 1914, p. 144. Taylor, 1945, p. 304, pl. 96, fig. 2.

STREBLOCLADIA CAMPTOCLADA (Mont.) Falk. — Peru: Callao, dredged off Isla San Lorenzo, *Schmitt 201*, Nov. 7, 1926. Bahía Independencia, dredged from 9 meters' depth east of Isla Vieja, *Schmitt 371D–35*, Jan. 12, 1935. Plate XIV, Figure 1.

Reference: Howe, 1914, p. 146.

UNIVERSITY OF MICHIGAN

LITERATURE CITED

AGARDH, J. G. 1872. Till Algernes systematik, nya bidrag. I. Caulerpa. Lunds Univ. Årsskr., 9 (8) : 1–45.

BORY DE ST. VINCENT, J. B. G. M. 1827–29. Botanique, Cryptogamie, pp. 1–96 (1827), 79–136 (1828), 137–300 (1829), Atlas, pls. 1–24 (1826?). *In* L. J. Duperrey, Voyage autour du monde, exécuté par ordre du roi, sur la Corvette de sa Majesté, la Coquille, pendant les années 1822, 1823, 1824 et 1825. Paris.

COLLINS, F. S. 1915. Some Algae from the Chincha Islands. Rhodora, 17 : 89–96.

DAWSON, E. Y. 1944. The Marine Algae of the Gulf of California. Allan Hancock Pacific Expeditions, 3 (10) : 189–453, pls. 31–77.

FELDMANN-MAZOYER, G. 1940. Recherches sur les Céramiacées de la Méditeranée occidentale, 510 pp., 191 figs., 4 pls. Alger.

HARVEY, W. H. 1844. Algae. *In* W. J. Hooker, Icones Plantarum . . ., VIII : i + viii, pls. 601–700, with accompanying descriptions. London.

HOOKER, J. D. [AND HARVEY, W. H.]. 1845, 1847. The Botany of the Antarctic Voyage of H. M. Discovery Ships "Erebus" and "Terror," in the Years 1839–43 under the Command of Captain Sir James Clark Ross, Kt., R.N., F.R.S., etc. I. Flora Antarctica. Part 1. Botany of Lord Auckland's Group and Campbell's Island. Algae, pp. 175–193 (1844). Part 2. Botany of Fuegia, the Falklands, Kerguelen's Land, etc. Algae, pp. 454–502. London.

HOWE, M. A. 1911. Phycological Studies — V. Some Marine Algae of Lower California, Mexico. Bull. Torrey Bot. Club, 38 : 489–514, pls. 27–34, 1 fig.

—— 1914. The Marine Algae of Peru. Mem. Torrey Bot. Club, 15 : 1–185, 66 pls., 44 figs.

HYLMÖ, D. E. 1919. Zur Kenntnis der subantarktischen und arktischen Meeresalgen. III. Chlorophyceen. Wissensch. Ergebn. schwed. Südpolar-Exped. 1901–1903, 4 (16) : 1–20, 33 figs.

KÜTZING, F. T. 1845–71. Tabulae Phycologicae oder Abbildungen der Tange. Vols. 1–20. Nordhausen.

KYLIN, H. 1924. Studien über die Delesseriaceen. Lunds Univ. Årsskr., N. F., Avd. 2, 20 (6) : 1–111, 80 figs.

—— AND SKOTTSBERG, C. 1919. Zur Kenntnis der subantarktischen und arktischen Meeresalgen. II. Rhodophyceen. Wissensch. Ergebn. schwed. Südpolar-Exped. 1901–1903, 4 (15) : 1–88, 1 pl., 38 figs.

LEVRING, T. 1941. Die Meeresalgen der Juan Fernandez-Inseln. *In* C. Skottsberg, The Natural History of Juan Fernandez and Easter Island, 2 : 601–670, pls. 49–53, 30 figs. Cf. Hedwigia, 81 (Beibl.) : (13). 1943.

—— 1942. Einige Meeresalgen von den Inseln San Ambrosio und San Felix. Bot. Notiser, 1942 : 60–62, 2 figs. Cf. Hedwigia, 81 (Beibl.) : (14). 1943.

(The papers by Levring just cited were received while this paper was in press, and too late to cite the contents in the body of the text. Twenty species are recorded as having been secured by the "Hassler" and Schmitt expeditions in the Juan Fernandez Islands.)

MONTAGNE, J. F. C. 1835. Prodromus Florae Fernandesianae. Pars prima, sistens enumerationem plantarum cellularium quas in insula Juan Fernandez a cl. Bertero collectas describi edique curavit. Ann. Sci. Nat. (Bot.), ii, 3 : 347–356.

—— 1839, 1847. Plantae cellulares. Algae, 7 : 1–110. 1839; 8 (Atlas): pls. 1–7. 1847. *In* A. d'Orbigny, Voyage dans l'Amérique méridionale. Seconde Partie. Florula boliviensis, stirpes novae vel minus cognitae. Cryptogamie. Paris and Strasbourg.

—— 1846. Cryptogames cellulaires. Algues, lichens, hépatiques et mousses, 1 : i–xi, 1–355. Atlas: pls. 141–145. *In* M. Gaudichaud, Botanique. Voyage autour du monde exécuté pendant les années 1836 et 1837 sur la Corvette la Bonite commandée par M. Vaillant, capitaine de Vaisseau. Paris.

MONTAGNE, C. 1852. Algas, pp. 228–393 *in* Claudio Gay, Historia fisica y politica de Chile. Botanica, 8 : 1–448. Paris.

NICHOLS, M. B. 1908–09. Contributions to the Knowledge of the California Species of Crustaceous Corallines, I, II. Univ. Calif. Publ. Bot., 3 (5–6) : 341–348, 349–370, pls. 9–13.

OKAMURA, K. 1936. Marine Algae, 964 + 11, port., 427 figs. Tokyo.

PICCONE, A. 1886. Alghe del viaggio di circumnavigazione della *Vettor Pisani*, 97 pp., 2 pls. Genova.

PILGER, R. 1908. Kleinere Beiträge zur Kenntnis der Meeresalgen I. Algen aus Peru und Chile. Hedwigia, 48 : 178–183, pl. 7.

REINKE, J. 1890. Übersicht der bisher bekannten Sphacelariaceen. Ber. d. d. bot. Gesellsch., 8 : 201–215, figs. 1–3.

SAUVAGEAU, C. 1900–14. Remarques sur les Sphacelariacées. Jour. de Bot., 14 : 1–51, 1900; 15 : 51–167, 1901; 16 : 167–288, 1902; 17 : 228–332, 1903; 18 : 332–348, 1904; pp. 349–634 (a separate publication), 1914.

SCHMIDT, O. C. 1923. Beiträge zur Kenntnis der Gattung Codium Stackh. Bibl. Bot., 91 : 1–68, 13 pls.

SETCHELL, W. A. 1929. The Genus Microdictyon. Univ. Calif. Publ. Bot., 14 (20) : 453–588, 105 figs.

—— 1937. The Codiums of the Juan Fernandez Islands. *In* C. Skottsberg, The Natural History of Juan Fernandez and Easter Island, 2 : 587–600, pls. 34–48.

—— AND GARDNER, N. L. 1925. The Marine Algae of the Pacific Coast of North America. Part III, Melanophyceae. Univ. Calif. Publ. Bot., 8 (3) : 383–898, pls. 34–107.

—— 1933. A Preliminary Survey of Gigartina, with Special Reference to Its Pacific North American Species. Univ. Calif. Publ. Bot., 17 (10) : 255–340, pls. 46–65.

—— 1937. Iridophycus, with Special Reference to the South American Species. Univ. Calif. Publ. Bot., 19 (6) : 195–244, pls. 23–29.

SKOTTSBERG, C. 1941. Marine Algal Communities of the Juan Fernandez Islands, with Remarks on the Composition of the Flora. *In* The Natural History of Juan Fernandez and Easter Island, 2 : 671–696, pl. 54.

SMITH, G. M. 1944. The Marine Algae of the Monterey Peninsula, California, ix + 622, 98 pls. Stanford University.

SUHR, J. N. VON. 1839. Beiträge zur Algenkunde, No. 3. Flora, 22 (I, 5) : 65–75, pls. 1–4.

—— 1840. Beiträge zur Algenkunde. Flora, 23 (I, 17) : 257–267; *ibid.*, 23 (I, 18) : 273–282; *ibid.*, 23 (I, 19) : 289–298.

TAYLOR, WM. RANDOLPH. 1928. The Marine Algae of Florida, with Special Reference to the Dry Tortugas. Carnegie Inst. Washington, Papers Tortugas Lab., 25 : 1–219, 37 pls., 3 figs.

—— 1930. Algae Collected by the "Hassler," "Albatross" and Schmitt Expeditions, I. Marine Algae from Brazil. Am. Journ. Bot., 17 : 627–634, pl. 39.

TAYLOR, WM. RANDOLPH. 1937. Marine Algae of the Northeastern Coast of North America, ix + 427, 60 pls. Ann Arbor.

—— 1939. Algae Collected by the "Hassler," "Albatross" and Schmitt Expeditions, II. Marine Algae from Uruguay, Argentina, the Falkland Islands, and the Strait of Magellan. Pap. Mich. Acad. Sci., Arts, and Letters, 24 (1938), Part I: 127–164, 7 pls.

—— 1942. Caribbean Marine Algae of the Allan Hancock Expedition, 1939. Allan Hancock Atlantic Exped. Report 2, pp. 1–193, 20 pls.

—— 1945. Pacific Marine Algae of the Allan Hancock Expeditions to the Galapagos Islands. Allan Hancock Pacific Expeditions, 12: i–iv, 1–528. 100 pls., 3 figs.

WEBER–VAN BOSSE, A. 1898. Monographie des Caulerpes. Ann. Jard. Bot. Buitenzorg, 15: 243–401, pls. 20–34.

—— 1913–28. Liste des algues du Siboga. I, Myxophyceae, Chlorophyceae, Phaeophyceae avec le concours de M. Th. Reinbold. Pp. 1–186, pls. 1–5, figs. 1–52 (1913). Liste . . . II, Rhodophyceae, première partie, Protoflorideae, Nemalionales, Cryptonemiales, pp. 187–310, figs. 53–109, pls. 6–8 (1921); seconde partie, Ceramiales, pp. 311–392, figs. 110–142, pls. 9–10 (1923); troisième partie, Gigartinales et Rhodymeniales . . ., pp. 393–533, pls. 11–16, figs. 143–212 (1928). Monographie LIXa de: Uitkomsten op zoologisch botanisch, oceanographisch en geologisch gebied verzameld in Nederlandsch Oost-Indië 1899–1900 aan boord H. M. "Siboga" onder commando van Luitenant ter Zee 1e kl. G. F. Tydeman. Leiden.

EXPLANATION OF PLATE I

FIG. 1. *Halopteris hordacea.* Branches with strobilus-like sporangium-bearing tips, showing the short deflected tetrastichously arranged branchlets. × 22

FIG. 2. *Griffithsia chilensis.* Branch bearing three laterally placed sporangial clusters, showing incurved branchlet tips and numerous polysporangia. × 33

1
2

EXPLANATION OF PLATE II

FIG. 1. *Bryopsis peruviana.* A group of plants, showing the form of the pinnate blades. × 1.5

FIG. 2. *Polysiphonia paniculata,* showing the habit of growth. × 1.0

1
2

EXPLANATION OF PLATE III

Halopteris hordacea. The habit of a fertile plant, showing the massive base and branching. Most of the tertiary branch tips may be seen to be fertile. × 1.1

EXPLANATION OF PLATE IV

Eisenia Cokeri, two juvenile stages

FIG. 1. Initiation of the smallest lateral lobes near the basal meristematic area. The irregularity of the end of the primary blade is due to tearing rather than to extensive decay. × 0.5. Howe's figures (1914, pls. 14–16) show the mature stages adequately

FIG. 2. Older stage with lateral lobes approaching the length of the primary blade, which has begun to decay. × 0.3

1
2

EXPLANATION OF PLATE V

FIG. 1. *Laurencia paitensis.* A considerable portion of a plant, the base concealed by Ulva, but showing the open branching. × 0.8

FIG. 2. *Gelidium filicinum.* The major portion of a plant, showing the branching. × 1.0

1
2

EXPLANATION OF PLATE VI

Gelidium congestum

FIG. 1. A portion of a relatively loosely branched plant, showing the basal attachments, naked erect axes, and the crowded upper branching. × 2.1

FIG. 2. A clump of a more densely branched specimen, showing the entangled basal stems and several erect axes with very crowded upper branching. × 2.1

1
2

EXPLANATION OF PLATE VII

Corallina chilensis

FIG. 1. A specimen from Areschoug's Peruvian Phyc. Extra-Europ. Exsic. 68. × 2.0

FIG. 2. A specimen from Callao, collected by Schmitt. × 2.0

1
2

EXPLANATION OF PLATE VIII

FIG. 1. *Dendrymenia Corallina.* An erect axis with a few indeterminate branches and small upper dichotomous blades. The acute-forked tips of some blades are due to the disintegration of terminal sporangial sori, which has left the margins as paired projections. × 0.5

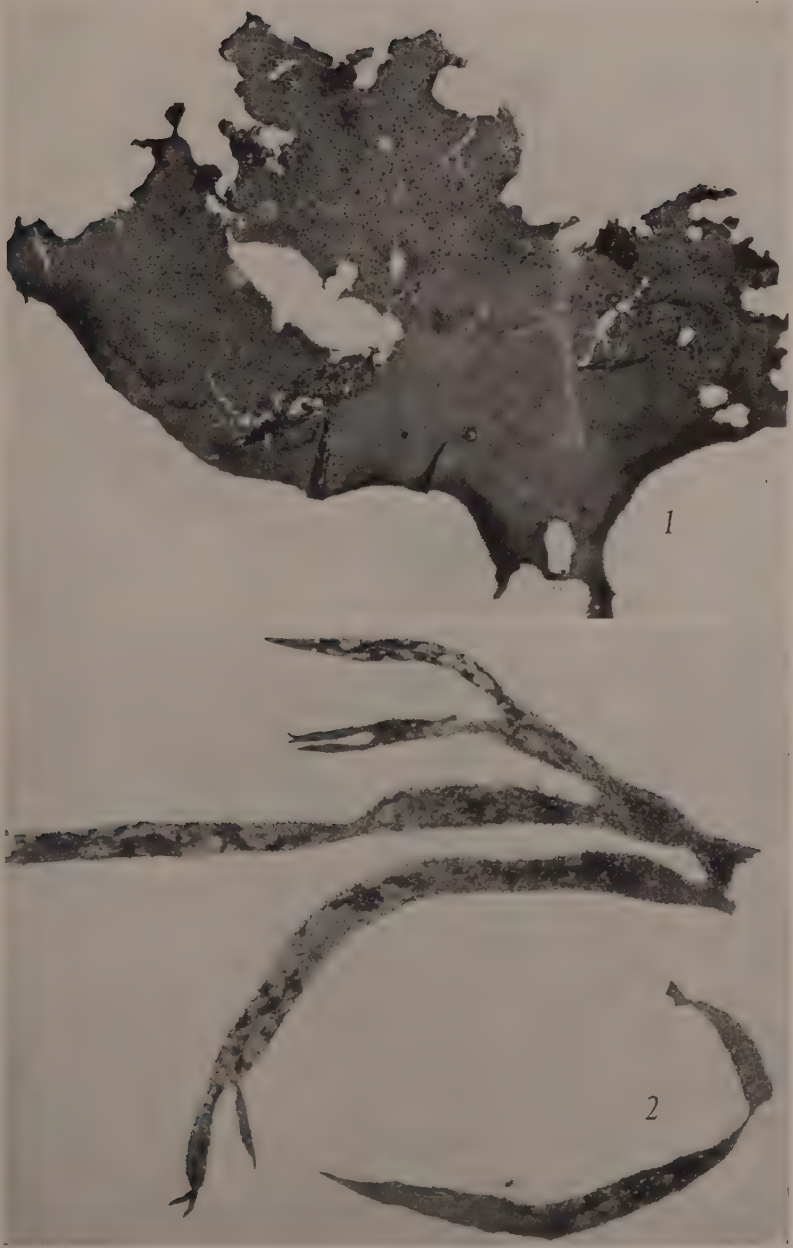
FIG. 2. *Halymenia foliacea.* A complete cystocarpic plant, showing the small base with proliferations and marginal lobes, and forking tip. × 0.3

1
2

EXPLANATION OF PLATE IX

FIG. 1. *Iridophycus ciliatus.* Major portion of a tetrasporangial blade, showing the small base and the minutely ciliate lower margins. × 0.75

FIG. 2. *Grateloupia denticulata.* Portions of a plant, showing the shape of the branches and the spinulose projections from them. × 0.37


1
2

EXPLANATION OF PLATE X

FIG. 1. *Sebdenia chichensis.* Two plants showing alternately expanded and narrowed blades with acute base and rounded tips. × 0.45

FIG. 2. *Sebdenia afuerensis.* A plant showing the very irregular branching. × 0.55

1
2

EXPLANATION OF PLATE XI

Gigartina paitensis

FIG. 1. A very loosely branched example. × 0.9

FIG. 2. A very closely branched example. × 1.2. Intermediates between these were represented in the same collection

1
2

EXPLANATION OF PLATE XII

Cryptopleura cryptoneuron

FIG. 1. A small portion of a spermatangial plant, showing the veinlets and the relatively broad segments strongly lobulate-crisped below. The paler marginal spermatangial sori show faintly near the left-hand and the lower right-hand margins of the figure. × 1.0

FIG. 2. The major part of a tetrasporangial plant, showing the relatively narrow segments somewhat crisped in the lower portions. The marginal tetrasporangial sori are quite dark and are evident on most of the upper branches. × 0.65

1
2

EXPLANATION OF PLATE XIII

FIG. 1. *Hemineura Hassleri.* The major portion of a sporangial plant, showing the branching of the axis and the lobing and marginal branching of the blades, which have strong midribs. The small, dark fertile lateral lobules can be distinguished. × 0.4

FIG. 2. *Cryptopleura peruviana.* A portion of a large and old plant, turned on its side. The axis runs from the left-hand border down toward the right and bears numerous proliferous branches. × 0.5

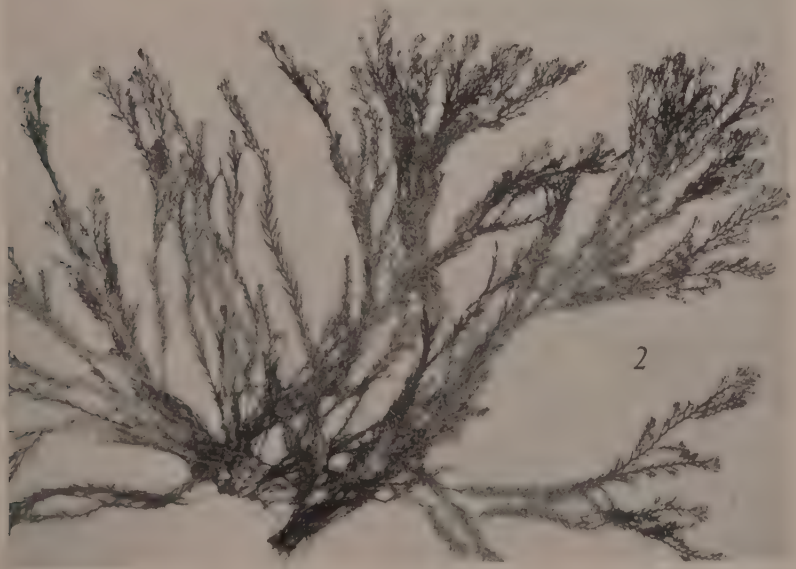
1
2

EXPLANATION OF PLATE XIV

FIG. 1. *Strebloclada camptoclada.* The upper branching of a clump, showing the habit. × 2.2

FIG. 2. *Pterosiphonia pennata.* The major portion of a clump, showing the habit, the main axes subsimple below, alternately branched above, with alternate simple branchlets throughout. × 1.7

1


2

FORESTRY

OCCURRENCE OF FUNGI IN THE MAJOR FOREST TYPES OF ALASKA *

DOW V. BAXTER

THE study of fungus populations in the various stages of development of a forest is relatively new, although it has been known for a long time that they play a definite rôle in the life cycles of plant communities. Often fungi are directly responsible for the changes in the composition of associations of higher plants. Furthermore, they frequently affect the rate of change. It seems clear, therefore, that ecological–pathological studies of the "normal" fungus cycle in major forest types will aid in planning effective measures for minimizing losses caused by pathogenic fungi. If it is possible to follow the history of a forest environment, with its types of fungus populations, back through various periods of development, we can likewise predict the probable future of certain plant associations, together with their forest fungi. In other words, it should be possible to foretell with a reasonable degree of accuracy what "pests" will occur in our future stands and, perhaps, what they will do. Of course, it is not feasible to forecast unusual outbreaks caused by fungi brought in from other countries or from outside areas any more than it is for an insurance company to make predictions for the appearance of an "unusual" disease in the human race. With information available concerning the incidence of certain fungi in different classes and age groups of stands, however, the forester will be able to anticipate need for protection and in some cases, at least, to take measures to prevent pests from developing (1).

* Throughout the several field seasons' work in Alaska much credit is to be given to the men, largely from the School of Forestry and Conservation of the University of Michigan, who aided in the collection of the specimens in the field, sometimes under difficult circumstances. Frank H. Wadsworth, W. Morris Morgan, Gordon L. Watts, Charles G. Allen, Robert Dimler, George Dick, Fred R. Walker, and Joe Hessel assisted in making the transects reported in this series of papers. My thanks are also due to the Horace H. Rackham School of Graduate Studies and to H. H. Bartlett, E. B. Mains, and Miss Ruth Chen-Ying Chou, all of the University of Michigan. Professor H. S. Jackson identified the several species of Alaskan Thelephoraceae mentioned.

My own studies of the rôle of fungi in plant succession have been carried out largely in Alaska, and in this article I present a series of observations made in five different forests of the Territory.

I. FOREST AND FUNGUS SUCCESSION OF INTERIOR RIVER VALLEYS WITH MEANDERING STREAMS

(Figures 1–2; Plates I–II)

The area that I have chosen as exemplifying the interaction of tree and fungus populations is in the Yukon River system below the mouth of the Tanana River, southwest to the mouth of the Koyukuk. The rivers of this large region have been cutting downward in some places, while depositing silt and gravel in others, until at present all the larger watercourses have broad, mature valleys. Cutting and deposition are still under way as the streams in flood sweep across the meanders, with consequent changes in the physiography of the region (2).

The forests of the alluvial flats are the largest and commercially the most important in the area. They contain chiefly white spruce (*Picea glauca* Voss.), balsam poplar (*Populus tacamahaca* Mill.), willows (*Salix sp.*), the white birch (*Betula alaskana* Sarg.), and alder (*Alnus crispa* Pursh). Willows are found on the new stream deposits and therefore commonly line the banks where deposition is in progress. The white and the black birches are small, especially the latter. Alder, often occurring with spruce, is not seen from the rivers except where the stream is cutting into a bank.

The Transect Method for Study of Succession

Forest succession and the occurrence of fungi in the different types were studied in detail by means of transects. One of these was established a mile below the junction of the Yukon and Koyukuk rivers (line *A–B*, Fig. 1). This transect crosses three bars designated *A*, *B*, and *C* (Fig. 2).

The first vegetation to appear on a new bar consists of willow, a few sedges, and some weedy annuals. Between the river and a sharply defined strip of driftwood there is no vegetation. Apparently the Yukon stood at the level of the driftwood until willows of the near-by region had borne fruit, and so had prevented the seed from falling on the area between the driftwood and the shoreline.

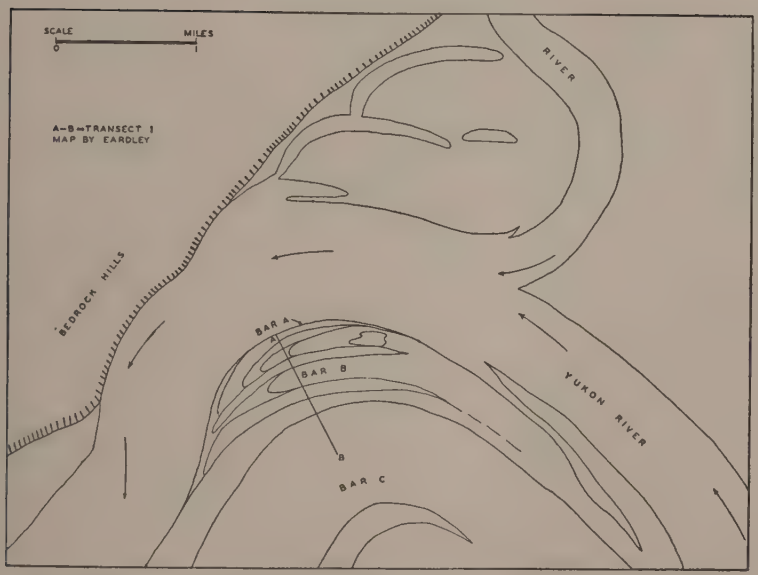


FIG. 1. Bar formation at the mouth of the Koyukuk River. Transect line *A–B* extends through the young forest in Bar *A* to the climax forest in Bar *B*

At a slightly higher level than that of the driftwood willow seedlings grow abundantly. Other tree species found on older bars do not occur on this site. Balsam poplar was not found but may be expected in such areas to a limited extent since it is common elsewhere along the Yukon.

The willow seedlings are so severely infected with rust, *Melampsora Bigelowii* Thüm., that many of them have been killed. The leaves of the living plants are red with the spores. In spite of the fact that numerous willows have been eliminated by the rust, the density of the stand has been maintained by the increase in size of the trees. A number killed by the fungus would have died regardless of infection because of severe competition for light.

The young willow forest reaches an age of approximately thirteen years on the older part of Bar *A*, where the trees are three to four inches in diameter. Competition for light is severe, and the number of stems has been reduced to 2,800 per acre.

The leaf rust of willow appears in this forest, but its effect upon

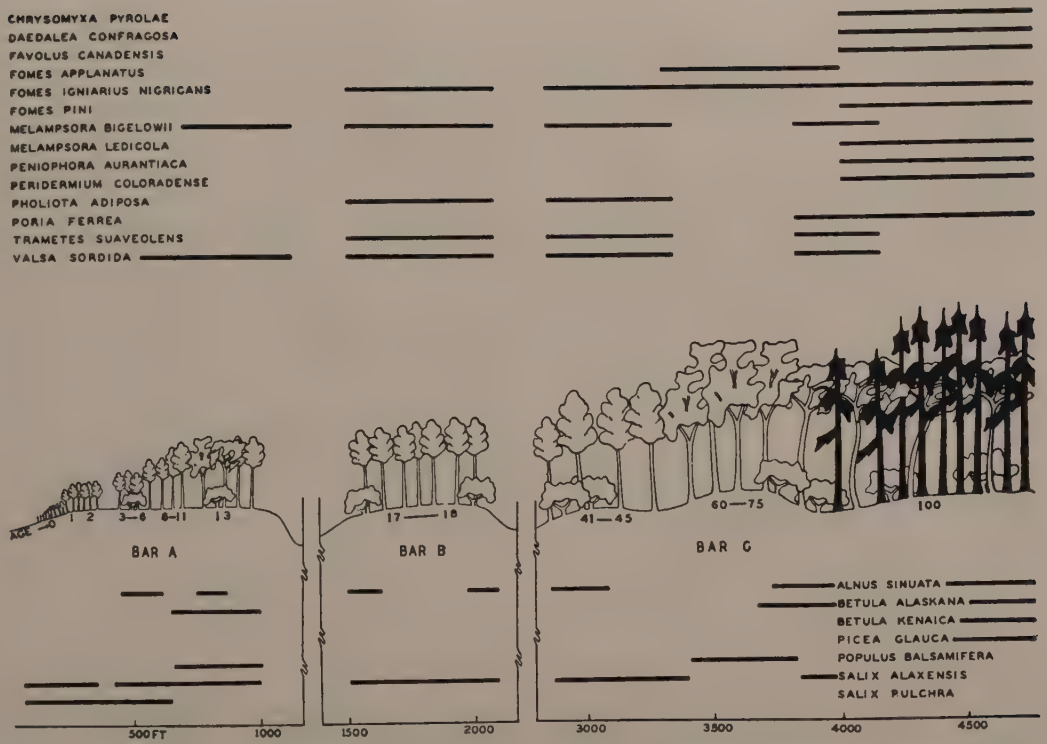


FIG. 2. Profile of a transect in the Lower Yukon Valley, Koyukuk, Alaska, as illustrated in Plates I and II. Lines drawn beneath the trees represent the species present. The lines above the trees represent the significant species of fungi that appear in the various forest communities. The distances of Bars *A*, *B*, and *C* from the Yukon are indicated in feet

these older trees is not noticeably significant. Valsa cankers, however, become prevalent.[1]

The overmature willow forest, forty to forty-five years old, is found on Bars *B* and *C*. Disease in the species here is more prevalent than on Bar *A*. On the willows Valsa cankers are often accompanied by rot caused by *Favolus canadensis* Klotzsch. Two other heart-rotting fungi are *Pholiota adiposa* Fr. and *Tramctes suaveolens* (L.) Fr. Young cankers often start around the bases of branch stubs and increase to a length of two feet or more. It is not unusual to see stems four and one-half inches in diameter with cankers six inches wide. The rust fungus, which is present, however, causes little or no serious damage.

In general, balsam-poplar forest follows the willow, although Salix and Alnus persist. Many willows in this forest are decayed by *Fomes igniarius* (L.) Gill. var. *nigricans* Fr. This heart-rotting fungus appears to be significantly destructive for the first time at this stage in the development of the forest and, together with *Pholiota adiposa*, causes a large amount of rot.

The mature forest is marked by the presence of spruce (*Picea glauca*). The willow has largely disappeared during the natural rotation, so that only a few live relicts remain. Birch (*Betula alaskana* Sarg.) is common in this forest and, in some low areas, alder (*Alnus crispa* Pursh) may occur.

The spruce, which is the least decayed of all trees on the transect, was generally sound. The comparatively little rot observed in standing spruce here is caused by *Fomes Pini* (Thore) Karst.

Though seriously attacked by *Fomes igniarius nigricans*, the birch will probably remain in the type to some extent, since it normally maintains itself as a minor constituent of mature spruce forest.

Résumé of the Tree and Fungus Development in the Forest of the Lower Yukon River

The young forest on new alluvial deposits of the lower Yukon is subject to a series of attacks by various fungi which affect the survival of successive forest trees. *Melampsora Bigelowii*, the first

[1] Young willows with diamond-shaped cankers are often cut and used for ornamental purposes. The bark is removed from the sticks, which are then highly polished and finished.

fungus to appear, is prevalent on the young willow of Bar *A*, where the seedlings, less than one year old, are killed by the rust, presumably selectively.

Other fungi and diseases do not appear until the crown canopy of the trees has closed over. On Bar *B*, for example, as many as six different fungi are common in the stand, including species that cause rot and cankers. In the willow forest forty to forty-five years old nearly half of the trees were damaged by either the canker-causing fungus, *Valsa sordida* Nitsch., or by heart-rotting fungi, and many by both. The chief heart-rotting fungi here are *Pholiota adiposa*, *Favolus canadensis*, and *Fomes igniarius nigricans*. The first is generally the most common, though in some areas either of the other fungi may be found more often.

The forest of this meander belt is also subjected to adverse conditions of site, such as frozen subsoil and ice damage. When the willow pioneers have closed over, changes in fungus populations will result, which may finally open up the stand. Growth of alder, birch, and spruce is thus facilitated. These different host species add directly to the fungus flora of the stand. The balsam-poplar forest, on the other hand, does not support a rich fungus flora. In the climax forest a number of fungi which were significant earlier in the history of the forest have disappeared. *Trametes suaveolens* and *Favolus canadensis* are examples.

The incidence of certain additional rust fungi has been favored by the recent appearance of their alternate hosts in the forest. Pyrola, Ledum, Vaccinium, and Chamaedaphne are examples of such hosts. The rusts which infect them are broom-stimulating on the spruce and, therefore, deform the tree, or the mycelium is not perennial in the twigs but is confined to the infected needles.

Fungi which destroy the heartwood of the spruce cause more damage than the rusts in the Alaskan forest. The ring-scale fungus *Fomes pini* appears for the first time in the climax forest, but in the particular forest studied does not occur abundantly. Both white and black birch are badly diseased in the climax type by *Fomes igniarius nigricans*, the heart-rotting fungus, which is the pathogen. Among the other fungi most common in this type, but not on the green standing timber, are *Trametes serialis* Fr., *T. variiformis* Pk., *Fomes pinicola* Sw. ex Cooke, *Poria xantha crassa* Karst., and *Poria crustulina* Bres. Members of this list are important in Alaska because they

destroy structural timbers. These plants are not found in the earlier communities mentioned.

II. FOREST AND FUNGUS SUCCESSION AFTER THE RETREAT OF A MOUNTAIN GLACIER

(Figure 3; Plates III–V)

It seemed of especial interest to determine the succession of woody vegetation in relation to the fungus population after the retreat of a mountain glacier. The area selected for study was located in the spectacular glacial region about Deadman's Glacier and the Bartlett Glacier near Tunnel, Alaska. These glaciers are in the old "loop district" of the Alaskan Railroad that ran to Anchorage from Seward, not far from the summit of the Chugach Mountains.

After the recession of the ice here there is a continually expanding land area exposed to plant invasion. Successive developmental stages of the forest, from pioneer to climax, may be seen in order as one goes away from the front of the glacier.

Nearest to the present ice edge the gravel is bare of plant life. Willows are among the first woody plants to colonize it. The most conspicuous herbaceous plants of the gravel are *Epilobium latifolium* L. and *E. angustifolium* L., which persist until eliminated from Salix by shade. Still farther back from the ice willows, together with alders, increase in size and number, forming dense thickets. Finally, a forest of mountain hemlock, *Tsuga Mertensiana* (Bong.) Carr. appears.

In the various phases of succession in the forest here there are notable differences from those of either the interior forest or those directly on the Pacific coastal slopes. The mature poplar forest, a phase in the succession of the river-bottom types of interior Alaska, as well as one following ice retreat in the development of the forest along the Pacific coast, is not significant in the present area.

Spruce is prominent in the climax forest of both the interior and the coastal forest. White spruce (*Picea glauca* Voss.) may actually form pure stands in many areas of the interior. On the coast a valuable commercial species, Sitka spruce (*Picea sitchensis* (Bong.) Carr.), appears in the climax. In general, however, hemlock (chiefly *Tsuga heterophylla* (Raf.) Sarg., but in some areas *T. Mertensiana* (Bong.) Carr.) grows under the spruce. Finally, a climax forest is

FIG. 3. Outline of vegetative types encountered from pioneer stages to the climax after ice retreat, as illustrated in Plates III and IV. Significant fungi that occur in the types are listed according to the zones that indicate various phases in the development of vegetation. Zone *A* (see Pl. III) is the area most recently freed from ice, but in the photograph it is hidden by the vegetation of Zone *C*

formed consisting of approximately three fourths hemlock and one fourth spruce. Spruce does not occur in the transect under discussion, but the succession proceeds directly from the willow and alder phases to the hemlock.

A transect one chain wide was run from the edge of the glacier, through the area of the first willows to invade the ice-freed ground, then through the willow and alder forest, and into the climax type, consisting largely of mountain hemlock. The fungi growing on the various trees and woods were recorded. The results were plotted and are presented in part in Figure 3.

Willows, which are among the first plants to colonize the ground

after ice retreat, are attacked during their first season by *Melampsora arctica* Rostr. At the glacier front, as in the interior meandering river belts, Melampsora affects the early development of the forest. Seedlings less than one year old are infected, and relative susceptibility to rust may be a material factor in natural thinning of the trees.

As soon as shade and competition become significant among the smaller broad-leaf trees (willow and alder) certain fungi are prevalent. *Hymenochaete agglutinans* Ellis on willow is one of them. *Stereum hirsutum* Willd. ex Fr., *Merulius niveus* Fr., and *Peniophora aurantiaca* Bres. are all common on alder. The complete decay of alder, however, is due to *Poria ferrea* Pers. ex Romell (see Fig. 3). Indeed, this fungus probably causes more decay of alder throughout Alaska than does *Fomes igniarius* (L.) Gill. var. *nigricans* Fr.

In the climax coniferous forest the same species of wood-rotting fungi that bring about decay of standing green trees and of fallen material in both interior and strictly coastal forests are present. *Fomes pini* (Thore) Karst. and *F. pinicola* (Swartz) Cooke are examples. *Aleurodiscus Weirii* Burt, reported from Idaho and British Columbia on *Abies grandis* Lindl., *Thuja plicata* Donn., and *Larix occidentalis* Nutt., is on hemlock in the climax forest.

The brown-felt fungus, *Herpotrichia nigra* Hart, occurs more commonly here in transects in the Chugach Mountains than in any of the others mapped. This is to be expected, since it is usual to find the organism at relatively high elevations or in localities of much snow. Large leaf areas become matted together by the mycelium, which grows over the foliage and induces death of the leaves and twigs of the host, chiefly by smothering.

Finally, it is of interest to note that certain prevalent fungi of the interior either are rare or do not appear in this forest type at all. The abundant rust fungus *Peridermium coloradense* A. & K. that causes witches'-brooms of white spruce in the interior forest does not occur in this area. Likewise, *Trametes isabellina* Fr., which commonly attacks fallen coniferous timbers throughout much of the Yukon Territory and interior Alaska, was not recorded on the transect.

It was observed that the farther away tree-infecting fungi are from the ice, the greater is their number up to a point where all the species of the Tsuga forest are present. Fungus populations, how-

ever, often depend not so much upon the number of different tree species but, in the case of the rusts, upon the abundance of specific and sometimes alternate hosts. For the most part the wood-attacking fungi occur where there is greatest abundance of host species within the forest. Here in the glacier-front forest the largest population appears to be in the "subclimax" type and just before the forest becomes mostly overmature hemlock, being determined by the factors of abundance and age of the tree species.

For many fungi found on the transect the age of the timber is a salient factor. *Fomes pini*, for example, was noted only in the mature stands of hemlock. The size of the wood may be significant with reference to the occurrence of such fungi as *Fomes pinicola*. It appears only on the large pieces of slash and stumps.

Many of the scavenger [2] fungi that are among the most ubiquitous in the states are not numerous here. *Polystictus versicolor* (L.) Fr. on hardwood slash and *Lenzites saepiaria* Fr. on coniferous slash are examples of species familiar farther south which are rare in this part of Alaska. *Pol. versicolor* is usually found, however, on woods other than those that occur in the Territory, and the glacial-front site under consideration is too wet for the best growth of both these species.

III. FOREST AND FUNGUS SUCCESSION WHERE FLORA INCLUDES SPECIES CHARACTERISTIC OF BOTH THE COASTAL AND THE INTERIOR FORESTS

(Figures 4–5; Plates VI–VIII)

A part of the Kenai Peninsula near the Russian River was selected for a transect study because the forest consists of species ordinarily confined to the coastal region and those of the Alaskan interior continental area. The geographical relations are indicated in the sketch map (Fig. 4). The country selected for observation illustrates more strikingly than any other I have discovered in North America the intermingling of interior continental spruce (*Picea glauca* Voss.) with the Sitka spruce of the rainy coastal forest (*P. sitchensis* (Bong.) Carr.). The extraordinary physiography of the region favors this mixing of types. High ranges along the Alaska

[2] It is common to refer to species such as *Polystictus versicolor*, which destroy fallen and dead timber, as "scavenger" fungi.

FIG. 4. The Kenai Peninsula, near the Russian River, was selected for a transect study because the forest consists of species ordinarily confined to the coastal region and of those of the interior continental area. The incidence of forest species is influenced by Cooke Inlet, which is a long fiordlike estuary typical of much of the sinuous coast line of Alaska, but reaching through the heart of the coast ranges to country with a central plateau climate near Anchorage

coast from the cape on the east side of Cooke Inlet to the northeast and east along the coast behind Seward and Prince William Sound produce a rain shadow over the central plateau, which has less annual rainfall.

Cooke Inlet is a long fiordlike estuary typical of much of the sinuous coast of Alaska, but reaching through the heart of the coast ranges to country with a central plateau climate near Anchorage (Fig. 4).

Forest succession and fungus populations in the various forest types were studied by a number of transects which formed a line through the white-spruce forests of the Alaskan interior types to the Sitka spruce–western hemlock forests at the base of a mountain (this came to be known by residents as "Baxter Mountain" on account of our party's activity there). Another transect was run up this mountain through the forest of Sitka spruce and western hemlock and through the mountain hemlock (*Tsuga Mertensiana* (Bong.) Carr.) to the alpine tundra (Fig. 5).

The interior forest consisted largely of aspen (*Populus tremuloides* Michx.) and white spruce (*Picea glauca*). The aspen, which appears after fires, is a common agent of destruction in the Alaskan interior forests, but is rare in the rain forest of the coast. Some birch (*Betula alaskana* Sarg.) also occurs. White spruce soon invades the aspen areas and eventually eliminates the "temporary forest" of *Populus tremuloides*.

The aspen is badly damaged by moose browsing. The effect, however, amounts to a "release" of the spruce and so may be considered beneficial with reference to commercial forest production, since spruce is the more valuable tree. *Fomes igniarius* (L.) Gill. attacks the aspen and causes its decay.

Birch leaves are often red with the spores of the birch–larch fungus, *Melampsoridium betulinum* (Pers.) Kleb. There is no larch, however, in the area.

The spruce soon becomes infected with the witches'-broom fungus, *Peridermium coloradense* A. & K. This rust is exceedingly common in the new-growth interior forests and often (though not necessarily) after fires. *Trametes variiformis* Peck and *T. odorata* (Wulf.) Fr. are among the chief fungi that decay old fallen spruce timbers remaining from the original spruce forest that preceded fire and the new poplar–spruce succession.

FIG. 5. Profile of a transect near the Russian River, Kenai Peninsula, as illustrated in Plates VI and VII. The interior forest is represented by the transect on the left. The transect passes through the coastal forest and up through the changing vegetative types as one climbs Baxter Mountain. Lines above the trees represent the chief wood-inhabiting fungi

The mature coastal forest consisting largely of Sitka spruce and western hemlock is attacked by specific rust fungi; the Sitka spruce needles, for example, are infected with *Chrysomyxa ledicola* (Peck) Lagerh. This rust causes some defoliation of the trees, but the injury is not serious. Both Sitka spruce and western hemlock become damaged by heartrot caused by *Fomes pini*. *Echinodontium tinctorium* Ell. & Everh. occurs on the hemlock, and in some areas it is particularly destructive of the mountain hemlock. *Fomes nigrolimitatus* (Romell) Egeland is also present on stumps and fallen trees, and *Polyporus alboluteus* Ell. & Everh. is common on Sitka spruce logs.

Succession of trees and, therefore, of tree-rust populations of the Alaska coastal mountains differs from that of the interior river valley districts. Major differences appear in climax types where Sitka spruce, western hemlock, and, in some localities, mountain hemlock occur instead of white spruce or black spruce. Here, where the coastal and the interior forest types appear in the same region, just as they do in the typical nontransitional forests of the coastal and the interior areas, well-defined relations exist between the different stages in the development of the forest and the species of fungi present.

The witches'-broom fungus, *Peridermium coloradense*, on white spruce, does not here attack Sitka spruce under natural conditions. Rusts are, of course, known for their high degree of specificity, but this is the first field evidence which has come to light regarding the susceptibility of Sitka spruce and white spruce to this rust.

Melampsoridium betulinum, the birch–larch fungus, is abundant in the interior forest, but it does not appear in that part of the transect that represents the coastal forest.

The Indian-paint fungus, which causes much cull in western hemlock and most of the decay in the true western firs, appears on the mature hemlock, but it does not attack any of the coniferous species in the near-by interior forest. This unusual area is a notable example of one where the spores of a western wood-rotting fungus (*Echinodontium tinctorium*) are undoubtedly present in the same forest with one of the northeastern conifers (*Picea glauca*), yet the fungus has not been found on this spruce. Eastern hemlock does not occur in the forest.

Both eastern as well as western hardwood-rot fungi in standing timber are seen on the species of the interior and coastal forest.

Fomes igniarius (L.) Gill. var. *nigricans* Fr. and *F. fomentarius* (L.) Kickx. are examples. These, in contrast to the restricted fungus just mentioned, may be found on woods of eastern or western distribution.

Fomes nigrolimitatus, first described from Lapland, is more frequent in the Alaskan coastal forest than in northern Europe. Here it occurs commonly on spruce in the mature coastal forest type, but it is not known on spruce in the interior forest.

Many of the fungi that destroy coniferous structural timbers in the northern United States are common to both the interior and the coastal forest. *Trametes variiformis* and *T. odorata* are in this group.

Trametes variiformis and other fungi of the same habit, largely confined to fallen timber, are more destructive of slash in the interior than in the coastal forest. Such common hardwood-attacking fungi as *Polyporus gilvus* (Schw.) Fr. and *Polystictus versicolor* (L.) Fr. (almost ubiquitous in the Lake States) are generally absent from both forest types in Alaska. *Polyporus radiatus* (Sow.) Fr., which might be expected on alder, does occur abundantly here.

One of the ecologically important facts which soon becomes too familiar to attract attention or to seem worth mentioning is that the rather rapidly growing slash-destroying fungus, *Fomes pinicola* (Swartz) Cooke, is conspicuously common in the coastal forest. The destruction of fallen timber, however, is slow beyond belief, for the reason that the precipitation is so great and evaporation so retarded that wood soon becomes covered with moss and, seemingly, is permanently water-logged; under these conditions the moss-covered wood remains undestroyed for a very long time and eventually even a sphagnum swamp, known as "muskeg," may be formed. It is often possible to observe such a muskeg on the side of a mountain where the forest has deteriorated into a swamp; in such places the change is accompanied by a relative decrease in wood-rotting fungi and a corresponding increase in mosses.

Polyporus alboluteus on spruce in the Kenai Peninsula extends through mixed interior and coastal forests, as it does in the majority of the states where any spruce grows.

The damaging root-rot fungus of conifers, *Polyporus Schweinitzii* Fr., although found commonly in the forests of the northwest Pacific, has not been observed in the white spruce timberlands of interior Alaska.

IV. FOREST AND FUNGUS SUCCESSION ON KODIAK ISLAND

(Figure 6; Plates IX–XIV)

Kodiak Island is located where the forest is invading land not recently occupied by ice, but altered by volcanic ash. The limit of the coastal coniferous forest of North America is on the eastern part of Kodiak Island. Beyond it the vegetation is chiefly grassland and tundra. Reports on the higher plants of this area have been published by the National Geographic Society, but nothing is said about the fungi.

In June, 1912, this island was disastrously affected by the eruption of Mount Katmai, which was one of the most tremendous volcanic explosions ever recorded. Griggs (4) reports that an area as large as the State of Connecticut was covered with ash and pumice to a depth varying from ten inches to over ten feet. Small amounts of ash fell as far as nine hundred miles away. Kodiak, almost one hundred miles distant, was the largest settlement in the section. The blanket of ash, according to Mr. W. J. Erskine, of Kodiak, who took the party of the National Geographic Society to the mainland, transformed the Kodiak region into a whitish desert.

Kodiak Island is now again covered with a rich vegetation, but some observations made by Griggs (4) are of particular interest because many of the host plants for the rust fungi are involved in the changes that have occurred.

> It must not be supposed that the old order of things has completely returned. The new vegetation is not altogether the same as that which was destroyed. It is true that the species are not the same as those dominant before the eruption, but the smaller species which formerly grew with the dominant plants were unable to pierce the ash blanket and were smothered. This was particularly true in the bogs or tundras, which formerly covered considerable areas. Even four or five inches of the ash was fatal to the bog plants, whose extermination was so nearly complete that it is difficult to find even individual survivors.
>
> Thus while the salmonberries and high-bush blueberries are finer than ever, the low-bush blueberries and cranberries are entirely lacking.

Formerly many of the species that grew in the bogs were found in the alpine heath that used to cover the exposed mountaintops, but Griggs notes that the eruption was equally fatal to them. Since the visits of the National Geographic Society's parties to Kodiak further growth of plants has taken place, and undoubtedly there is now a richer vegetation, which in turn affects fungus populations.

Since these edaphic changes are unparalleled and since the coastal coniferous forest of North America ends so abruptly that photographs can be taken to show the virtual margin of tree invasion, an unusual opportunity was afforded to study fungus populations here under the conditions that have determined the forest and that permit its advance under the ameliorating influence of climatic change.

A transect one chain wide was established from the mountaintop back of Kodiak (Fig. 6). The beginning of the transect was beyond the edge of the advancing spruce forest and was run through that part of the eastern section of the island where the area is occupied by a dense forest of Sitka spruce.

The mountaintop vegetation is largely alpine in nature. Dwarf birch (*Betula glandulosa* Michx.) and *Empetrum nigrum* L. are among the common plants of this type. Dwarf birch was infected here by *Melampsoridium betulinum* (Pers.) Kleb., and *Empetrum nigrum* was attacked by the rust fungus *Chrysomyxa Empetri* (Pers.) Schroet. This fungus, which was abundant at least during the year that these studies were made, had previously been unknown from North America, but records of its occurrence in Asia are available. *Puccinia Heucherae* (Schw.) Diet. on *Heuchera glabra* Willd. was also collected. *Melampsora arctica* Rostr. occurs on the willows.

As one follows the transect from the alpine vegetation to the areas where Sitka spruce is invading previously unforested land for the first time, it is interesting, indeed, to the student of plant associations to note that there is nothing here comparable to the successional stages after fire in the interior forest, or after deposition of new alluvium in the river valleys. There is nothing to correspond, for instance, with the poplar stage of the successions. Rather, there is a nonforest climax formation meeting with a subclimax phase of the forest, and practically nothing occurs in the way of a transition. Climatic conditions are now favoring the extension of forest, which, in its climax phase (if it is to be like that of the coastal areas of the Chugach and Tongass National Forests bordering the Pacific), unrepresented on Kodiak, will be spruce–hemlock, but which in the subclimax phase, the only one yet represented, is spruce alone. Just at the forest edge goldenrod and fireweed (*Epilobium angustifolium* L.) are found. The rust *Coleosporium Solidaginis* (Schw.) Thüm., a less common fungus in Alaska than in the states, appears on the

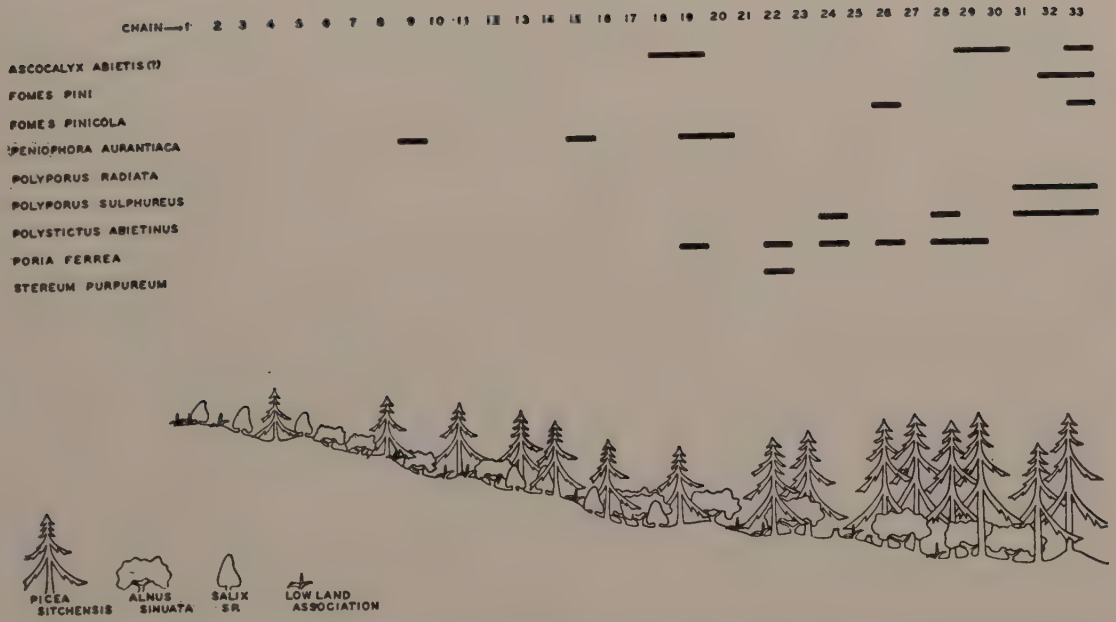

CHAIN—1' 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33
ASCOCALYX ABIETIS (?)
FOMES PINI
FOMES PINICOLA
PENIOPHORA AURANTIACA
POLYPORUS RADIATA
POLYPORUS SULPHUREUS
POLYSTICTUS ABIETINUS
PORIA FERREA
STEREUM PURPUREUM
PICEA SITCHENSIS
ALNUS SINUATA
SALIX SP.
LOW LAND ASSOCIATION

FIG. 6. Profile of a transect that extended from the top of the mountain back of the village of Kodiak to include a part of the Sitka spruce forest, as illustrated in Plates IX, XI, and XII. The occurrence of the chief wood-inhabiting fungi along the transect is illustrated by the bars above the trees

goldenrod, and the fireweed is infected with *Pucciniastrum Epilobii* Otth. Willows, which are also present, are infected with the rust *Melampsora arctica*. *Nectria Coryli* Fckl. also occurred on Salix. *Diaporthe sociabilis* var. *Sambuci* (E. & E.) Weh. was found on elder.

The spruce-needle rust, *Chrysomyxa ledicola* (Peck) Lagerh., is found almost as soon as the spruce is encountered. It causes much less damage on older trees.

Because the Sitka spruce trees are scattered when they first invade an area, they develop large and numerous limbs. It requires years for additional spruce that have seeded in later to grow up and eventually shade out the branches so as to cause their death. Much more time is necessary for these old limbs to fall off; but finally they offer points of infection for both *Polyporus sulphureus* (Bull.) Fr. and *Fomes pini* (Thore) Karst. In the oldest part of the forest many of the trees are defective because of heartrot caused by these two fungi. The coniferous structural-timber enemy, *Trametes serialis* Fr., was collected here on fallen spruce (3). Pyrolas appear commonly in the Sitka spruce forest, and many are infected with the rust *Chrysomyxa Pyrolae* (DC.) Rostr.

Low areas within the Sitka spruce forest are occupied by alders, many of which are dying out. *Poria ferrea* Pors. ex Romell is the common cause of rot in the majority of the stems, but such fungi as *Polyporus radiatus* (Sow.) Fr. and *Pol. sterioides* Fr. ex Romell were also collected.

The forest on Kodiak does not contain either western hemlock or mountain hemlock. It will be recalled that Tsuga, in general, makes up almost 75 per cent of trees in the older Sitka spruce–hemlock forest elsewhere in Alaska in the coastal area bordering the Pacific Ocean. Fungi restricted to hemlock are therefore absent on Kodiak Island.

The rust fungus *Melampsoridium betulinum* on Betula was abundant in the alpine tundra on Kodiak Island, even though the host plant for the alternate phase (Larix) does not occur on it.

Chrysomyxa Empetri, known hitherto only from Asia, was found on *Empetrum nigrum*, which grows in the alpine tundra.

The salix rust *Melampsora arctica* was found throughout the transect, but is most abundant where the forest of spruce has not yet become densely stocked. Alternate phases of this rust appear on members of the Saxifragaceae.

Coleosporium Solidaginis is much less common throughout Alaska

than in most parts of the Lake States and in many other localities of the United States. However, this rust of goldenrod was found on the transect area mapped. Alternate phases of it are on species of pines, but there are no pines on Kodiak Island, nor are there any species of this genus over vast regions of the near-by mainland.

The rust that attacks *Epilobium angustifolium* L. appeared abundantly on the transect. It is of interest that on Kodiak Island not only are there no species of Abies that are hosts for the alternate phase of this rust, but that no representatives of this genus occur much nearer than the mountains that border the Yukon Territory.

Puccinia Heucherae, a common rust on the mainland, was found abundantly on Kodiak Island. It does not, however, have an alternate tree host.

The spruce-needle rust, *Chrysomyxa ledicola*, is present on *Picea sitchensis* (Bong.) Carr. The alternate phase of it occurs on Ledum, a bog plant that has probably survived the eruption of Katmai. It is to be noted, however, that the rust was found on the spruce host and not on Ledum. It is possible that association of both hosts may not be necessary for infection of the spruce.

Pyrolas, however, are low plants that would be easily buried by the ash. They are common on the island. Furthermore, the rust *Chrysomyxa Pyrolae* was recorded for the transect. It attacks Sitka spruce as well as species of Pyrola.

V. FOREST AND FUNGUS SUCCESSION AFTER THE RETREAT OF A GLACIER IN THE PACIFIC COASTAL REGION

(Figure 7; Plates XV–XVIII)

Forest succession and the occurrence of different fungus populations in the forest types that follow the ice retreat was traced near Valdez, Alaska, on Prince William Sound. Historically this area is well known because hundreds of prospectors crossed the Valdez Glacier on their way to the Yukon in the gold rush.

A 312-chain transect, one chain wide, was run from the foot of the glacier through the various types of vegetation that have developed since the retreat of the ice. The woody plants observed that were either substrata or hosts for the different fungi were recorded.

The first woody vegetation to appear after ice retreat consisted of willows and a few cottonwood seedlings. The willows were infected

with the rust fungus *Melampsora artica* Rostr. Farther away from the ice an old forest of cottonwood is found. Many of the trees are now dead, the result of alluvial depositions made by sudden rises of streams emanating from the glacier. Later colonizing plants have reinvaded these areas, and so the forest is actually in many stages of development. An unusually large population of wood-rotting fungi is therefore present as well as the group of rusts that are ordinarily found chiefly in the juvenile forest. The fungi noted here are indicated in Figure 7.

The climax forest of Sitka spruce and western hemlock prevalent in the coastal forests along the Pacific has not formed. It does occur, however, on near-by areas and supports, in general, the identical fungi found elsewhere for this forest type (2).

As in the first forest types of interior Alaska that appear on newly formed soil, the rust fungi are among the first to attack the invading willows after retreat of the tidewater glacier. *Melampsora arctica* is abundant, especially in the young forest. *Pucciniastrum Pyrolae* (Pers.) Schroet. does not appear until several years later, when favorable forest conditions have been created by the poplar, and therefore not until many years after the first willow and cottonwood have grown on the gravel bars. This rust appeared first in chain 213. *Pucciniastrum Epilobii* Otth. was found on chains 285, 286, and 287 (i.e. some distance from the ice). The tree host for this fungus is supposed to be Abies. Among the western species of this genus the fungus is reported on *A. concolor* Lindl. & Gord., *A. grandis* Lindl., *A. lasiocarpa* (Hook.) Nutt., and *A. nobilis* Lindl. There are no species of Abies at all in this part of Alaska. Abies is known to occur in the far-off panhandle region across the Gulf of Alaska. The fungus that causes tar spot of willow, *Rhytisma salicina* (Pers.) Fr., like the Melampsora rusts, also appears early in the life of the forest.

Most tree- and wood-inhabiting fungi, however, are not found until after the poplar has matured and until later vegetational associations appear. This phenomenon was observed in the development of the spruce forest in the meander belt of the lower Yukon and on many of the transects established elsewhere. On the Valdez Glacier transects, however, a relatively large number of fungi do occur in the poplar forest.

On the interior Alaskan transect, in contrast to the Valdez transect, plant succession from the willow to the poplar forest and

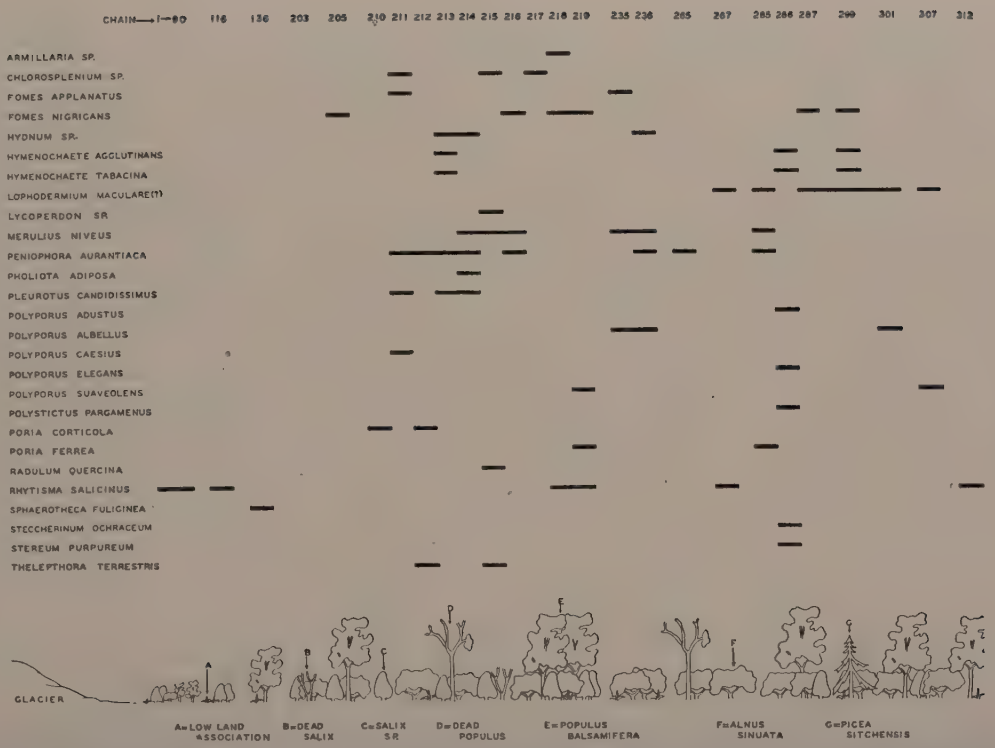


FIG. 7. Profile of a transect in the area of the Valdez Glacier, as illustrated in Plates XV, XVI, and XVII. Lines drawn above the trees represent the chief wood-inhabiting fungi present

to spruce has been gradual. In the Valdez area there is abundant evidence that the process has been interrupted and has not been a continuous one from pioneer phases to the climax forest. A large number of mature poplars that have been killed by sudden deposition of gravel from swollen glacial streams are present in the Valdez area. Partial burial by gravel has killed many mature cottonwood trees. This has resulted in reinvasion by colonizing plants and in unduly long persistence of vegetation that belonged to earlier phases in the succession. These plants are now associated with the dying and dead trees of a later phase. Consequently, fungi that ordinarily occur during different periods in the history of the forest are found here. Not only do catastrophes alter the species in the forest itself, therefore, but such environmental factors likewise have a marked effect upon the incidence of forest fungi.

University of Michigan

LITERATURE CITED

1. Baxter, Dow V. 1941. Pathology in Forest Practice, 618 pp. John Wiley & Sons Inc., New York.

2. —— and Wadsworth, Frank. 1939. Forest and Fungus Succession in the Lower Yukon Valley. Bull. 9, School of Forestry and Conservation, University of Michigan, Ann Arbor.

3. —— and Varner, Reed W. 1942. Importance of Fungi and Defects in Handling Alaskan Airplane Spruce. Circ. 6, School of Forestry and Conservation, University of Michigan, Ann Arbor.

4. Griggs, Robert F. 1917. The Valley of Ten Thousand Smokes. National Geographic Magazine, 31 : 13–68.

PLATES I–XVIII

FIG. 1. View as one looks west along the north edge of Bar A (see Fig. 1). The rows of seedlings along the water's edge came from willow seeds that were washed ashore during the spring. The beach on the river side was under water during the season when the seeds were disseminated

FIG. 2. The willow in the foreground is one year old; that in the background is two years old. This regular stairlike arrangement is characteristic of this vegetation

FIG. 1. Zone of vegetation that occupies the area between bars once under water. The ground cover consists largely of Equisetum, Rubus, and a few alders

FIG. 2. Interior Alaskan white spruce forest along a slough of the Yukon River

The area selected for the study of forest and fungus succession after the retreat of a mountain glacier in the spectacular region about the Bartlett Glacier, near Tunnel, Alaska. This glacier is in the old "loop district" of the Alaskan Railroad. The vegetation types, which are separated by the dashed lines, are indicated by letters. They correspond to those shown on the transect in Figure 3

FIG. 1. Alder thicket characteristic of Zone B and part of Zone C

FIG. 2. The mountain hemlock Zone D in the foreground. Looking toward the alder of Zone B and the ice front of the Bartlett Glacier

Fomes pini (fruiting body in center) on *Tsuga Mertensiana* in mountain hemlock Zone D. This heart-rotting fungus is the representative of the genus here, although *Fomes pinicola* on fallen trees is common in this zone

FIG. 1

FIG. 2

FIG. 1. Interior spruce, *Picea glauca*, Russian River transect, Kenai Peninsula

FIG. 2. Alaskan coastal forest, consisting chiefly of western hemlock and Sitka spruce. The large-leaved plants in the foreground are devil's-clubs

FIG. 1. Lower Russian Lake (right foreground), looking toward Skilak Glacier, Kenai Peninsula. Fire-killed timber is common in interior Alaska. The transect included a part of Baxter Mountain (to the left)

FIG. 2. Hemlock forest on Baxter Mountain, through which the transect was run. A Sitka–western spruce hemlock forest grows at the base. White spruce of the Alaskan interior forest is to be seen in the central background and in the area of the Kenai (above center)

FIG. 1. Mountain hemlock type, Kenai Peninsula. This hemlock is overmature and is badly decayed by *Echinodontium tinctorium*

FIG. 2. Mountain hemlock, on Baxter Mountain

The edge of the coastal coniferous forest in North America (at the extreme right in the photograph), with the town of Kodiak in the foreground. The photograph, taken in 1938, should be compared with the one published in the *National Geographic Magazine*, 31 (1917) : 15, which shows the grass vegetation on the mountain in August, 1916. The transect extends from the mountain in the background to the edge of the spruce forest

FIG. 1

FIG. 2

FIGS. 1 2. The eruption of Mount Katmai in June, 1912, threw a mass of ash and pumice into the air which buried an area as large as the State of Connecticut. The ash, which fell like snow on the branches (Fig. 1), can still be shaken from the moss-covered limbs. A layer of ash (Fig. 2) buried the vegetation to a depth ranging from ten inches to over ten feet.

FIG. 1. The beginning of the transect beyond the edge of the advancing spruce forest. The mountaintop vegetation is largely alpine

FIG. 2. Sitka spruce invading previously unforested land for the first time

FIG. 1. View from the mountain toward the village of Kodiak and Spruce Island. Early Russian maps show Spruce (Wood) Island, evidently so named because of the presence of timber during the period of their occupation.

FIG. 2. Sitka spruce forest invading grasslands of Kodiak Island. The transect extended into the forest

Sitka spruce and the remnant alder forest, Kodiak Island. *Poria ferrea* is common on alder here

FIG. 1

FIG. 2

FIGS. 1 2. *Polyporus sulphureus* (Fig. 1) and *Fomes pini* (Fig. 2), which are common causes of heart rot in Sitka spruce

Forests that have developed since the ice retreat, Valdez, Alaska. The transect studies were made in the forests in the middle foreground. The Valdez Glacier, not shown in the photograph, is to the left

Edge of the Valdez Glacier. A 312-chain transect, one chain wide, was run from the foot of the glacier through the various types of vegetation that have developed since the ice retreat

Mature poplars killed by the deposition of gravel from swollen glacial streams from the Valdez Glacier. This catastrophe has resulted in reinvasion by colonizing plants and unduly long persistence of vegetation that belonged to earlier phases in the succession

FIG. 1

FIG. 2

FIG. 1. The use of the increment borer in determining tree ages on the Valdez transect

FIG. 2. *Fomes applanatus* on dead *Populus tacamahaca*, Valdez transect

SOME RESUPINATE POLYPORES FROM THE REGION OF THE GREAT LAKES. XVII *

DOW V. BAXTER

THE merit of taxonomic effort is determined by its usefulness to others. In spite of the multiplicity of lists and descriptions of the polypores of this or that area no work which covers a continent is available. Furthermore, even for a region no treatise exists which seems to be generally usable.

There is much disagreement not only between American and European classifications, but among American reports themselves. Some represent strictly morphological viewpoints, whereas others have to do entirely with classifications based upon physiological reactions of the fungus. Still others attach considerable importance to the reactions of the host to a single species or race of a wood-rotting fungus and are definitely interested in the ecological relationships as well. Many whose activities are directed to prevention, control, and salvage measures point to the number of names often applied to the same fungus and, because of the many possible approaches to the subject, believe that it is now almost a hopeless task to identify positively some of the fungi with which they are concerned.

Furthermore, much difficulty is experienced in interpreting data of the fungi in culture and in comparing them with the results obtained by various investigators. The collecting of specimens in

* Throughout the work on these monographs I am indebted to many individuals and institutions for suggestions, help, and privileges extended to me. Grants from the Horace H. Rackham School of Graduate Studies of the University of Michigan have greatly facilitated both the field and the laboratory studies. My appreciation is expressed particularly to the men who have accompanied me on my numerous expeditions to Alaska, the Yukon Territory, and the Northwest Territories. Much credit is due them for aiding in the collection and care of specimens and for living, at times, under rather difficult circumstances. I am under obligation to Professors T. G. Halle and Gunnar Samuelson, of Naturhistoriska Riksmuséet in Stockholm, with whom I have had the pleasure of association. Thanks are also due to several American institutions and scholars. To the authorities at the New York Botanical Garden, to the staff of the Division of Pathological and Mycological Collections of the United States Department of Agriculture, and to Professor H. H. Bartlett, of the University of Michigan, I am especially indebted.

different seasons and regions, differences in chemicals and formulas for making media and in the duration of the tests, and variations in procedure and the recording of data have all contributed to render the task a large one and often an unsatisfactory one.

The design for the present study has been to formulate as complete a record of the group as is feasible at this time. This necessitated, therefore, the examination of fresh material from all the principal forest types of the continent and collecting in practically every state, province, and territory. An effort was made to do work in areas for which there were few or no records. Nevada, Utah, Oklahoma, Rhode Island, New Brunswick, the Northwest Territories, the Yukon, and Alaska may be cited as specific examples.

Many American fungi were taken to Europe and compared with types, cotypes, and important specimens deposited in European herbaria, especially in the Scandinavian countries. The Berkeley collections at Kew Gardens, London, Romell's specimens at the Naturhistoriska Riksmuséet, the Bresadolan plants at Stockholm, the specimens at Uppsala, the Karsten herbarium at Helsingfors, and the Persoon collections at Leiden received special attention during two visits to the continent. Studies were made in several other herbaria, such as those at Leningrad and Edinburgh. Field work on the fungi involved excursions chiefly in England and Scotland, Norway, Sweden (including Swedish Lapland), Denmark, Finland, Russia, Germany, France, Switzerland, and Czechoslovakia. The areas about Stockholm and Uppsala received special attention. Specimens deposited in the leading American herbaria have been studied.

The present paper discusses ten species of fungi and describes one new resupinate polypore. A comprehensive treatment of the resupinate polypores of North America is planned.

The color terms enclosed in quotation marks are those of R. Ridgway, *Color Standards and Color Nomenclature* (1912).

Polyporus trichomallus Berk. & Mont., Ann. Sci. Nat., III, 11 : 238. 1849

(Plate I)

Funalia trichomalla Pat., Tax. Hymén., p. 95. 1900.

Trichaptum trich(o)m(o)allum (Berk. & Mont.) Murrill, Bull. Torrey Bot. Club 31 : 608. 1904.

Polyporus Perrottetii Lév. ex Lloyd, 3 : Sec. Funales, p. 63. 1910.

Fructification effused-reflexed, laterally connate, sometimes resupinate and often covering the entire under surface of logs, reflexed parts 3–12 mm., 1–10 × 5–20 (or more) × 5–12 mm.; surface fuliginous "drab" to almost black, sometimes zonate, conspicuously covered with long intricately interwoven hairs that are approximately 37–100 μ in diameter; margin thin, sterile below, "avellaneous," loosely fibrous and darker above, the entire fruiting body, except the tubes and the thin layer to which they are attached, composed of the loose branched fibers; tubes short, mostly 1–2 mm. long, avellaneous within, mouths angular, sometimes daedaloid, about 0.5–2 mm., mostly 0.5–1, edges thin, entire, "wood brown," "avellaneous," to "mummy brown," soon becoming lacerate or irpiciform; spores not seen; hyphae of the intricately woven hairs long, flexuous, nonseptate, brownish, 2–4 μ in diameter, hyphae of the tube layer hyaline to mostly faintly brown, rarely branched, 2–3 μ in diameter.

Allied species. — *Polyporus trichomallus* may be confused with *Trametes hydnoides* since both species are characterized by long intricately branched hairs on the surface. *Pol. trichomallus* is a felty, pliable plant with large irregular pore mouths, whereas *T. hydnoides* is more rigid, and the pore mouths are smaller and regular. The context and pores are more brownish gray than the definitely brown context and pores of *T. hydnoides*. The surface hairs often disappear in age in *T. hydnoides*, but they remain in *Pol. trichomallus*.

Habitat. — *Casurina equisetifolia, Persea borbonica, Populus deltoides.*

Distribution. — Florida, Texas.

Remarks. — Lloyd states that this plant was named *Polyporus Perrottetii* by Léveillé. Later Montagne described the plant as *Pol. trichomallus* "from the same collection, and everyone without exception since has used Montagne's name, notwithstanding that all legal authority provides to the contrary" (5). The name *Pol. trichomallus* has become so well established that nothing is to be gained by changing to *Pol. Perrottetii*.

Polyporus amorphus Fr., Syst. Myc., I : 364. 1821

Polyporus irregularis (Sow.) Romell ex Murrill, in Mycol., 10 : 109. 1918.
Tyromyces amorphus (Fr.) Murr., Mycol., 10 : 109. 1918.

Fructification thin, tough and pliant when fresh, sessile, effused-reflexed, 0–6 × 1–3 × 0.1–0.3 cm., or resupinate; surface white to gray, "pale cinnamon drab," tomentose or villose-pubescent; margin thin, sterile below; tubes flesh color to orange or red, i.e. "vinaceous buff," "apricot buff," "apricot orange," "hazel," appearing somewhat resinous or waxy, 1–2.5 mm. long; mouths angular, concolorous with the tubes, 2–5 to a mm.; basidia 3–4 μ in diameter; spores 3.5–5 × 1–2 μ (Lowe); cystidia none; hyphae rarely or not much branched, 3–5 μ.

Allied species. — *Polyporus amorphus* may be confused with *Pol. dichrous* because the tubes may appear somewhat waxy or resinous. The mouths are larger in *Pol. amorphus*, being 2–4 to a mm., whereas in *Pol. dichrous* they are 5–7 to a mm. The hymenium of *Pol. amorphus* does not peel off in a thin smooth layer in fresh specimens.

Habitat. — *Abies balsamea, A. grandis, Picea Engelmannii, P. sitchensis, Pinus attenuata, P. contorta, P. echinata, P. monticola, P. ponderosa, P. pungens, P. rigida, P. Strobus, P. taeda, Pseudotsuga taxifolia, Sequoia sempervirens, Tsuga canadensis.*

Distribution. — California, Idaho, Maine, Montana, North Carolina, Oregon, Pennsylvania, South Carolina, South Dakota, Virginia, Wyoming.

Occurrence. — *Polyporus amorphus* attacks the sapwood of coniferous logs and is reported on fallen pine needles (6). It infects only a small number of woods. It can be seen from the list of species presented here that pine is a common substratum.

Decay. — The rot of the sapwood of *Pinus rigida* caused by *Polyporus amorphus* has been described by Overholts. The infected wood first changes from its usual light color to "cinnamon buff." Finally, a stringy rot is formed which is characterized by elongated cavities and bands of wood. The elongated cavities represent the spring wood that is destroyed before the summer wood disappears. This separation of spring and summer wood results in the formation of concentric rings. They do not coincide entirely with the annual rings, but the annual rings are split into their two growth areas, spring and summer wood. The rotted wood may be readily separated into narrow strings or strands when twisted. When dry, the rotted wood is brittle and snaps under light pressure. Sheets of mycelium do not develop in the cavities, and no spots or colored lines of any kind are present in the decayed wood (6).

Polyporus compactus Overh., Bull. Torrey Bot. Club, 49 : 170. 1922

Specimens observed :

Polyporus compactus Overh. on *Quercus alba*, Lakeland, Michigan.

Polyporus compactus Overh. on Quercus, Pa. Det. John Stevenson. Herb. Mycol. Coll., Bureau Plant Industry, Washington, D.C.

Fructification nodulose, resupinate, effused up to 15 cm., whitish, watery to corky, 3–8 mm. thick, disagreeable odor; pileus, if present, not more than 1 cm. broad and 1.5 cm. thick (Overh.); tubes less than 2 mm. long, frequently lacking or poorly formed; mouths averaging 4 to a mm., basidia large, pyriform, 9–10 μ in diameter; basidiospores ellipsoid or ovoid, hyaline 7.5–9 $\times$ 4.5–6 μ; chlamydospores 6–7.5 μ, abundant on the hymenium and formed singly on the context hyphae, subglobose to broadly ellipsoid, colorless or slightly greenish or yellow under the microscope, 7.5–9 $\times$ 6–7.5 μ; cystidia mixed with the basidia as narrow, pointed flask-shaped structures, 3–4 μ in diameter; hyphae of two types: (*a*) large, hyaline, unstaining, frequently thick-walled, 3–5 μ in diameter; (*b*) small, staining and much branched, with a few clamp connections, 2–3.5 μ.

Habitat. — *Quercus alba.*

Distribution. — Michigan, New Jersey, Pennsylvania.

Occurrence. — Rare. On standing dead trunks or on stumps, especially on *Quercus alba.*

Cultures. — Features of *Polyporus compactus* have been obtained in culture by Davidson, Campbell, and Vaughan (3). The growth of the fungus is moderately rapid, forming a radius of 30 to 35 mm. in seven days. The mat exhibits a white, appressed, compacted, tough, thin felty growth, usually with nodulose patches and yellowish, guttulate, abortive poroid areas either scattered or forming a wide circle about the center. These areas are composed of dense masses of chlamydospores and only occasionally produce basidia and basidiospores. A positive oxidase reaction is given by the fungus, which indicates that it causes a white rot.

The fungus exhibits prominent clamps. Chlamydospores in culture are ellipsoid to barrel-shaped, 9–12 $\times$ 6–9 μ; basidiospores rare, hyaline, truncate, 6–9 $\times$ 4–6 μ.

The optimum temperature for growth has been determined to be approximately 30° C.

Decay. — A white heartrot is produced.

Remarks. — The description of the fruiting body presented here is based upon that given by Overholts.

The peculiarities of the fruiting body, however, can be demonstrated in pure culture. In culture it is usually entirely resupinate and is composed of a mass of chlamydospores. Pores are poorly formed, and basidia and basidiospores are difficult to locate. In culture abortive yellowish poroid areas develop in both petri dishes and test tubes. This poroid tissue is composed of masses of chlamydospores identical in size and shape with those found in the normal fruiting body (3).

Poria Bracei Murr., Mycologia, 13 : 91. 1921

Type and important specimens examined:

Poria Bracei. Type. Nassau, New Providence, Bahamas, 1918, L. J. K. Brace. No. 9594, covering under surface of the bottom of a barrel. Herb. New York Botanical Garden, New York.

Poria Bracei. Murr. 1427. Rio Piedras, Puerto Rico, Feb. 22, 1914. J. R. Johnston & J. A. Stevenson. Herb. New York Botanical Garden, New York.

Poria Bracei. Dade County, Florida, J. S. Stevenson. Det. J. R. Weir, 1613. Herb. Mycol. Coll., Bureau Plant Industry, Washington, D.C.

Poria Bracei. Murr., near Miami, Florida, Dow V. Baxter, Sept. 29, 1944. Herb. Dow V. Baxter, Ann Arbor.

Fructification widely effused for as much as 75 cm. and covering the exposed wood surface or decayed organic matter in a felty mat reviving from year to year and forming a mat up to 3 mm. or more in thickness; margin conspicuous, membranous, persistent, wine-colored to lilac; context conspicuous, concolorous with the mouths, mostly 0.5 mm. thick; tubes mostly 0.5 to 1.5 mm. long each season; mouths "fawn color," "cinnamon drab," to "drab gray," 5–6 to a mm., edges entire; spores globose, hyaline 4 μ (Murr.).

Allied species. — There are no species closely allied to this conspicuous plant in North America. It should be pointed out that *Polyporus Bracei* Murr. (*Mycologia*, 11 [1919] : 222) is not the same plant, for it has a stipe and a different color and is not at all related.

Habitat. — On hardwood logs and decayed organic matter.

Distribution. — Florida. Also known from the Bahamas and Puerto Rico.

Occurrence. — This unusual poria was discovered first in North America by John Stevenson in Dade County, Florida. I made

collections of it in the same general locality thirty years later, in 1944.

Trametes hydnoides (Sw.) Fr., Epicr., p. 490

Boletus hydnoides Sw., Prodr., 149. 1788; Fl. Ind. Occid., 3 : 1924. 1806.
Boletus hydnatinus Bose, Ges. Nat. Freunde Berlin Mag., 5 : 84, pl. 4, fig. 3. 1811.
Polyporus pellitus G. Meyer, Fl. Esseq., p. 304. 1818.
Boletus crinitus Spreng., Sv. Vet., Acad. Hydl., 1820 : 51. 1820.
Boletus fibrosus Hook. in Kunth, Syn. Pl., 1 (10). 1822.
Trametes ocellata Berk. & Curt., Journ. Linn. Soc., 10 : 319. 1868.
Polyporus Feathermanni Rav., Grevillea, 6 : 130. 1877.
Pogonomyces hydnoides (Sw.) Murr., Bull. Torrey Bot. Club, 31 : 609. 1904.

Important specimen:

Polyporus Feathermanni Rav., Gainesville, Florida. Fungi Americani Exsiccati. H. W. Ravenel. Herb. New York Botanical Garden, New York.

Fructification sessile, often imbricate, 3–5 × 5–10 × 0.5–1 cm. (Murr.); surface zonate, "army brown," "bone brown" to nearly black, conspicuously covered with rigid branched fibers, which often disappear with age; margin entire or undulate, sterile below; context brown, fulvous, zonate, corky, 3–5 mm. thick; tubes mostly about 5 mm. long; mouths mostly circular 3–4 to a mm. "Prout's brown," "mummy brown" to blackish; dissepiments thick, entire; spores oblong, smooth, hyaline, 8–10 × 3–4 μ; no cystidia.

Allied species. — *Trametes hydnoides* is not a resupinate polypore, but because it may be confused with *Polyporus trichomallus* (which is often resupinate or effused-reflexed), it is included in this series. Both species are characterized by long intricately branched hairs on the surface. *T. hydnoides* is not felty and pliable, as is *Pol. trichomallus*. *T. hydnoides* is corky, as are most temperate-zone species of Polystictus, but, unlike felt, is not pliable. The pore mouths of *T. hydnoides* are small and regular, whereas those of *Pol. trichomallus* are relatively large and irregular. The context of *T. hydnoides* is definitely brown; that of *Pol. trichomallus* is gray brown. The surface hairs often disappear in age in *T. hydnoides*, but they remain in *Pol. trichomallus*.

Habitat. — *Acacia aurifera, Carya pecan, Casurina equisetifolia, Celtis sp., Chrysobalanus sp., Citrus aurantifolia, Damburneya catesbyana, Ficus brevifolia, Fraxinus berlandieriana, Gleditsia sp., Juglans nigra, Leucaena glauca, Liquidambar Styraciflua, Magnifera indica,*

Platanus sp., Prosopus julifora, Prunus persica, Quercus myrtifolia, Q. Phellos, Q. virginiana, Taxodium distichum, Trema mollis, Ulmus sp.

Distribution. — Florida, Louisiana, Mississippi, Texas.

Occurrence. — *Trametes hydnoides* is more abundant in Florida than elsewhere in North America, but is not uncommon in Texas and Louisiana. It appears to be rare in Mississippi and is not known from any of the other states.

Cultures. — Isolated by Davidson, Campbell, and Blaisdell (2), who report that it gives a positive reaction to tannic acid media.

Poria zonata Bres., Mycologia, 17 : 77. 1925

Type:

Poria zonata Bres. on *Abies grandis*, Priest River, Idaho. Coll. & det. James R. Weir. Ex 71007, Herb. Mycol. Coll., Bureau Plant Industry, Washington, D.C. New York Botanical Garden, New York.

Fructification broadly effused, white; margin sterile; subiculum membranaceous, 0.5 mm. wide; tubes 1–3 mm. long; mouths irregular, 1–2 to a mm.; basidia 18–20 × 3.5–4.5 μ; spores hyaline, cylindrical-curved, biguttulate, 5–6 × 2–2.5 μ; hyphae 2–4 μ; cystidia 45–46 × 15–18 μ.

Allied species. — *Poria zonata* suggests *P. ambigua*, but may be distinguished from it not only because of habitat differences but also because of its conspicuous stereum-like border, and its spores, which are 2–2.5 μ wide, cylindrical and not obovate, ellipsoid, 3–3.5 μ wide. The border will also serve as a differentiating feature to separate *P. zonata* from *P. sinuosa*. Furthermore, the spores of *P. sinuosa* (a form of *P. vaporaria*) are only 1–2 μ wide.

Habitat. — *Abies grandis.*

Distribution. — Idaho.

Remarks. — The description is based upon that of Bresadola.

Poria grandis Overholts, Mycologia, 35 : 249. 1943

(Plate II)

Part of type:

Poria grandis on *Tsuga canadensis*, 71421 Herb. Mycol. Coll., Bureau Plant Industry, Washington, D.C.

Fructification effused, soft-membranaceous, separable, at first entirely pale sulphur yellow, the sterile margin and subiculum re-

maining so in dried specimens, elsewhere pale avellaneous or grayish on drying, with small yellowish mycelial strands that penetrate the rotten substratum; subiculum tissue evident, soft, tough, yellow; tubes not more than 1 mm. long, yellow within, the pore surface at first pale yellow, whitening at maturity, but on drying becoming isabelline, the pores obliquely gaping or more regular, angular, thin-walled, entire, averaging about 3 per mm.; spores ellipsoid to broadly ellipsoid, smooth, hyaline, 3–4 × 2–3 μ; no cystidia; hyphae of subiculum 3–4.5 μ in diameter, all thin-walled, septate, and clamped.

Allied species. — This membranaceous, rather soft species suggests *Poria mollusca* as known by contemporary students in Sweden. The more or less pale yellow color and the soft appearance are similar to those of many specimens I have collected in that country. If, however, a specimen of *P. grandis* is collected that is fruiting readily, the plant may possibly suggest an immature *Poria subacida* Pk. The mycelial strands, the generally membranous nature of the fungus, and the relatively short tubes serve as features by which *P. grandis* may be separated from *P. subacida.* Because *Poria subacida* causes much butt rot in northern coniferous swamps on trees other than cedar and is also believed to be a possible cause of decay in *Thuja occidentalis,* the finding of a closely allied polypore on cedar may make difficult diagnoses of decay alone.

Habitat. — *Thuja occidentalis, Pinus flexilis, Tsuga canadensis.*

Distribution. — Michigan, Minnesota, New Mexico, Tennessee.

Polystictus cinnabarinus (Jacq.) Sacc., Syll. Fung., 6 : 245. 1888

Boletus cinnabarinus Jacq., Fl. Austr., 4 : 2. 1776.
Boletus coccineus Bull., Herb. Fr., p. 364. 1791.
Polyporus cinnabarinus (Jacq.) Fr., Syst. Myc., 1 : 371. 1821.
Trametes cinnabarinus (Jacq.) Sacc., Syll. Fung., 6 : 245. 1888.
Pycnoporus cinnabarinus (Jacq.) Karst., Rev. Myc., 3 : 18. 1881.

Fructification corky to rigid, dimidiate, 1–5 × 2–10 × 0.5–2 cm., or sometimes resupinate, surface azonate, tomentose to glabrous, "light salmon orange," "vinaceous rufous," "apricot orange," "Mars orange," "vinaceous tawny," margin thin, acute, sterile below; context concolorous, 0.1–2 cm. thick; tubes concolorous

with context, 1–4 mm. long, mouths brick red or orange, "apricot orange," "vinaceous rufous," 2–4 to a mm.; spores hyaline to yellowish, cylindric, 5–7 × 2–3 μ (Shope); no cystidia, hyphae of the context seldom branched, thick-walled, 4–8 μ in diameter.

Allied species. — This species is closely allied to even more colorful *Polyporus* (*Trametes*) *sanguineus* (L.) Fr., and Weir (6) suggests that they may be identical. One might well consider *Pol. cinnabarinus* a northern form of *Pol. sanguineus* because of certain differences here noted. It is seldom, if ever, substipitate, but *Pol. sanguineus* is characteristically so; it is a thicker plant, usually being 5 mm. thick, whereas *Pol. sanguineus* is less than 3 mm. thick; it is a less brilliant red, i.e. "apricot yellow" or "Mars yellow," in contrast to the "flame scarlet" or "English red" that are customary for *Pol. sanguineus.*

Because the names are well known and have so frequently appeared in the literature, for the time being it is not believed necessary to establish a new variety until it can be demonstrated that the two are distinct in culture.

Habitat. — *Abies balsamea, Acer glabrum, A. rubrum, A. saccharum, Betula fontinalis, B. glandulosa, B. lenta, B. lutea, B. papyrifera, B. papyrifera occidentalis, Castanea dentata, Fagus grandifolia, Hicoria ovata, Ilex opaca, Juglans cinerea, Liquidambar Styraciflua, Liriodendron tulipifera, Nyssa sylvatica, Picea rubra, Pinus caribaea, P. edulis, P. palustris, Populus angustifolia, Prunus pennsylvanica, P. serotina, P. virginiana, Quercus alba, Q. borealis maxima, Q. catesbaei, Q. nigra, Q. palustris, Q. Prinus, Q. texana, Q. utahensis, Q. velutina, Q. virginiana, Sabal palmetto, Salix sp., Sassafras officinale, Sorbus americana, Thuja plicata, Tilia americana, Tsuga canadensis, Ulmus americana.*

Distribution. — British Columbia, Manitoba, Ontario, Quebec, Yukon Territory, Alaska, Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming (44 states).

Poria limitata (Berk. & Curt.) Cooke 14 : 113. 1886

(Plate III)

Polyporus limitatus Berk. & Curt., Berk., Grevillea, 1 : 54. 1872.

Important specimens observed:

Poria limitata Langlois, Louisiana. Herb. New York Botanical Garden, New York.

Fructification annual or perennial, appearing in more or less orbicular or elongated, somewhat coriaceous patches not uncommonly about 3 × 5 cm., but usually about 1.5 × 4 cm., mostly on bark of standing trees; inseparable to separable; margin often conspicuous as on undulating border, tomentose, sterile, whitish or "pale pinkish buff," 0.5 to 3.5 mm., mostly 0.5 mm. wide; subiculum "pinkish buff," mostly less than 0.3 mm. thick; tubes up to 1.5 mm. long each season, mostly 1 mm. long; mouths whitish, "pale pinkish buff" to "pinkish buff," circular, thick-walled, entire, 4–5 to a mm.; basidia mostly two-spored, spores hyaline, smooth, somewhat angular, ovoid, 5.5–7 (8) × 5.5–7 μ; no cystidia, or sometimes cystidium-like structures (hyphal pegs?) present; hyphae or the hymenium thin, narrow, much branched, 1–3, mostly 2 μ wide; without clamp connections.

Allied species. — *Poria limitata* suggests *P. unita* because of the somewhat coriaceous fruiting bodies, their color, and the thick-walled entire mouths of the tubes. It is not, however, widely effused over the substratum (which in *P. unita* may often be decorticated). It appears in small patches over the bark of standing tree trunks and often on the dead branches of living trees. Without a close examination the numerous small fruiting bodies on the bark may even remind one of those of *Aleurodiscus oakesii.*

Poria unita occurs on many different types of substrata and is widely distributed throughout the continent. *P. limitata* is found chiefly on oak and is mostly a southern species.

Habitat. — *Quercus virginiana.*

Distribution. — Florida, Mississippi, New Jersey, South Carolina.

Occurrence. — Most porias grow on fallen logs or on decorticated wood in the forest or on structural timbers and other wood products. *Poria limitata* appears usually on the bark of standing live oaks throughout the Gulf states and the southeastern coastal

regions. It usually thrives wherever the live oak and closely related species of oak occur.

Remarks. — Bresadola found to be sterile the specimen from the Berkeley Herbarium that I saw at Kew. This specimen bore some resemblance to *Poria papyraceae* (Schw.) Cooke, since the mouths were rather large, i.e. 3–4 to a mm. *P. papyraceae* is mostly a conifer-inhabiting fungus.

Poria viridiuscula, sp. nov.

(Plates IV–V)

Type:

Poria viridiuscula, sp. nov., on *Liriodendron tulipifera*, Athens, Georgia. October 3, 1944. Coll. Dow V. Baxter and Lyle Jackson. Herb. Dow V. Baxter, Ann Arbor.

Planta resupinata, cum fructificatione annua, late effusa vel sequens rimas corticis usque ad 5 m., crassitudine minus quam 3 mm., viridiuscula, albida, vel salmonicolor, aliquando nitida, siccitate saepe tenuem subtranslucentem membranosam laminam formans; margine interdum 15 mm. lata sed plerumque 2–3 mm.; tubis plerumque circa 2 mm. longis, sed si siccis solum 0.3 mm., vel brevioribus 4–5 per mm.; sporis 3–4 μ longis, 1–2 μ latis; hyphis hyalinis, 2–5.5 μ crassis, plerumque 2–2.5 μ. Cystidia desunt. Specimen typicum legerunt Dow V. Baxter et Lyle Jackson, Athenis, Georgia, Oct. 3, 1944; in herbario auctoris conservatum, sub numero AZ 23156.

Fructification annual, resupinate over large areas or following the crevices of the bark for as much as 5 meters, effused for approximately 5 meters; when fresh "ivory yellow," "marguerite yellow," "pale olive buff" to "olive buff," drying to "buffy citrine" or "dark olive buff" to "mummy brown," at first up to 3 mm. thick, but drying to a thin skinlike glassy surface that does not resemble the fructification of the fresh poria in color or texture; margin up to 15 mm. or more, but mostly 2–3 mm. wide, conspicuous in dried material; tubes mostly about 2 mm. long in fresh plants, but drying to 0.3 mm., mostly less in herbarium specimens and becoming somewhat translucent; mouths 4–5 to a mm., appearing translucent in dried plants; spores 3–4 $\times$ 1–2 μ, hyphae hyaline, 2–5.5 μ, mostly 2–2.5, in diameter, no cystidia.

Allied species. — Fresh growing plants appear entirely different from

dried specimens. This conspicuous whitish poria, which soon becomes faintly pale greenish or "pale olive buff," does not closely resemble any of the whitish porias when fresh. The distinct cystidia which are present in *Poria corticola* are not found in *P. tacamahacae* Baxter. Thus fungus is recognized by its pale greenish white pore surface when fresh, and it, too, may dry to a thin skinlike sheet. The tubes of *P. tacamahacae* are longer in the dried plants, and herbarium material is of a different color. *P. tacamahacae* is more yellowish, i.e. "cream buff," "colonial buff"; in thick specimens, however, it is sometimes red brown, i.e. "Verona brown." In culture *P. viridiuscula* does not exhibit the pronounced glassy appearance characteristic of *Poria tacamahacae.*

In some herbaria this plant may possibly be found under the name of "*Poria vitreus.*" Donk (4) had described the spores of *P.* (*Podoporia*) *vitrea* Fr. non Pers. as globose 4.25–5 μ and under that species lists as synonyms "*Pol. undatus* Pers. Myc. Eur. 2:90 (t. 16 f. 3), 1895; Lloyd Syn. Apus Pol. 321 (f. 662, 663), 1915; *Poria undata* (Pers.) Bres. in Ann. Myc. 1:78, 1903; Bourd. et Galz." I have seen no evidence in Holland or in Sweden that this plant from Georgia should be called *Pol. vitreus.* The spores of the Georgia plant should readily separate it from the one Donk records. This collection emphasizes, however, the need for an understanding of the fresh plant since in the fresh state this poria is much different from the dried material. Only herbarium specimens might be confused with *P. vitreus.*

Habitat. — *Aesculus glabra, Liriodendron tulipifera.*

Distribution. — Georgia, Tennessee.

Cultures. — Isolated from *Liriodendron tulipifera,* Athens, Georgia. *Poria viridiuscula* grows readily on malt-extract agar and produces tubes within two weeks in petri-dish cultures. The colors that it exhibits in nature, however, are not distinct in such tests. The olive or pale green appearance, i.e. "pale olive buff" to "olive buff," is evident when *P. viridiuscula* is grown on either red-gum or white-pine blocks. A thin whitish mycelial growth covers such blocks within three months, but it does not mask the shape of the test pieces within that time. Tubes are formed on both agar and wood blocks; and on the blocks they first appear as nodules. Fructification occurs on both conifers and hardwood.

A conspicuous white rot, marked by shrinking and collapsing of both red-gum and white-pine test pieces, results after a one-year inoculation period. The rate of decay is approximately the same in both types of wood.

Cultures of *Poria viridiuscula* grow equally well in the light and the dark. This plant belongs to the "rapid-growth" class of porias since it fills the petri dish within a seven-day period at the temperature for best growth. Tests for growth at temperatures below 25° C. have not been made, but *P. viridiuscula* develops rapidly at both 25° C. and 30° C. Growth is retarded rapidly at 35° C. There is almost no growth within seven days at this temperature and only approximately 20 mm. within a two-week period.

University of Michigan

LITERATURE CITED

1. Baxter, Dow V. 1943. Pathology in Forest Practice, 618 pp. New York: John Wiley & Sons, Inc.

2. Davidson, Ross W., Campbell, W. A., and Blaisdell, Dorothy J. 1938. Differentiation of Wood-Decaying Fungi by Their Reactions on Gallic or Tannic Acid Medium. Journ. Agric. Res., 57: 683–695.

3. —— —— —— 1942. Fungi Causing Decay of Living Oaks in the Eastern United States and Their Cultural Identification. Tech. Bull. U. S. Dept. Agric., pp. 1–65.

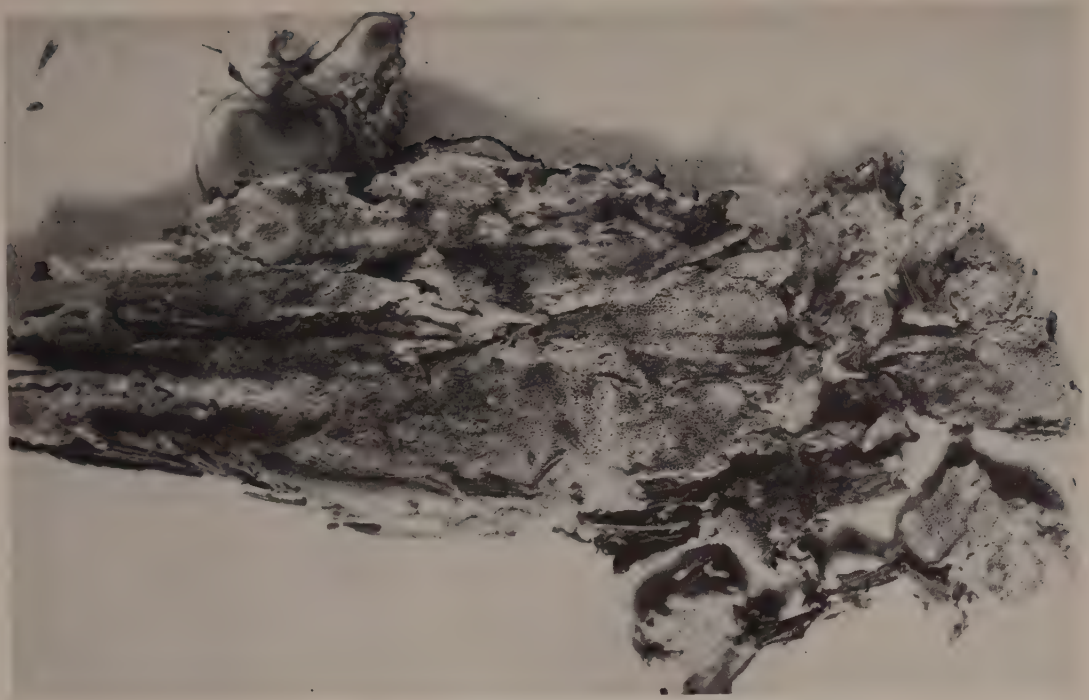
4. Donk, M. A. 1933. Revision der niederländischen Homobasidiomycetae Aphyllophoraceae. II. Mededeelingen van Het Botanisch Museum en Herbarium van de Rijks Universiteit te Utrecht, No. 9, 1–278.

5. Lloyd, C. G. 1910. Synopsis of the Sections Microporus, Tabacinus and Funales of the Genus Polystictus, 3: 66.

6. Overholts, L. O. 1917. An Undescribed Timber Decay of Pitch Pine. Mycologia, 9: 261–270.

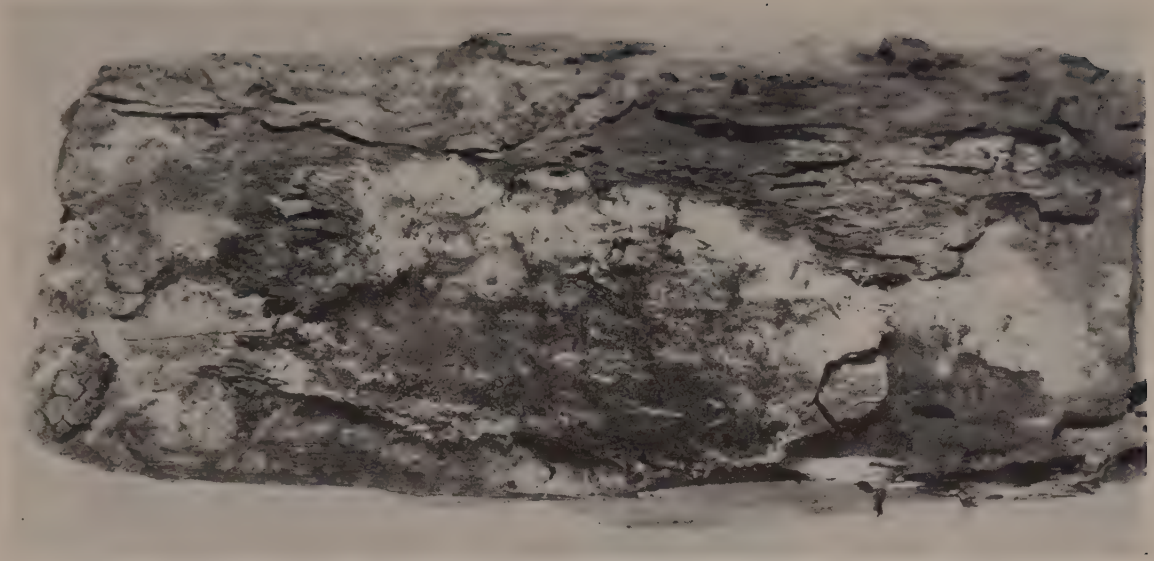
7. Weir, James R. 1919. Concerning the Introduction into the United States of Extralimital Wood-destroying Fungi. Mycologia, 11: 64.

Polyporus trichomallus on *Persea borbonica*. Miami, Florida



Poria grandis on *Tsuga canadensis*. No. 71421, Mycological Collections, Bureau of Plant Industry, Washington, D.C.

Poria limitata, substratum unknown, California



Poria viridiuscula, sp. nov., on *Liriodendron tulipifera*, Athens, Georgia. Herbarium specimen

Poria viridiuscula, sp. nov., isolated from *Liriodendron tulipifera* and growing on test blocks of *Liquidambar Styraciflua*. The living plant differs from dried specimens in color, thickness, lack of glassy skinlike appearance, and absence of a conspicuous margin